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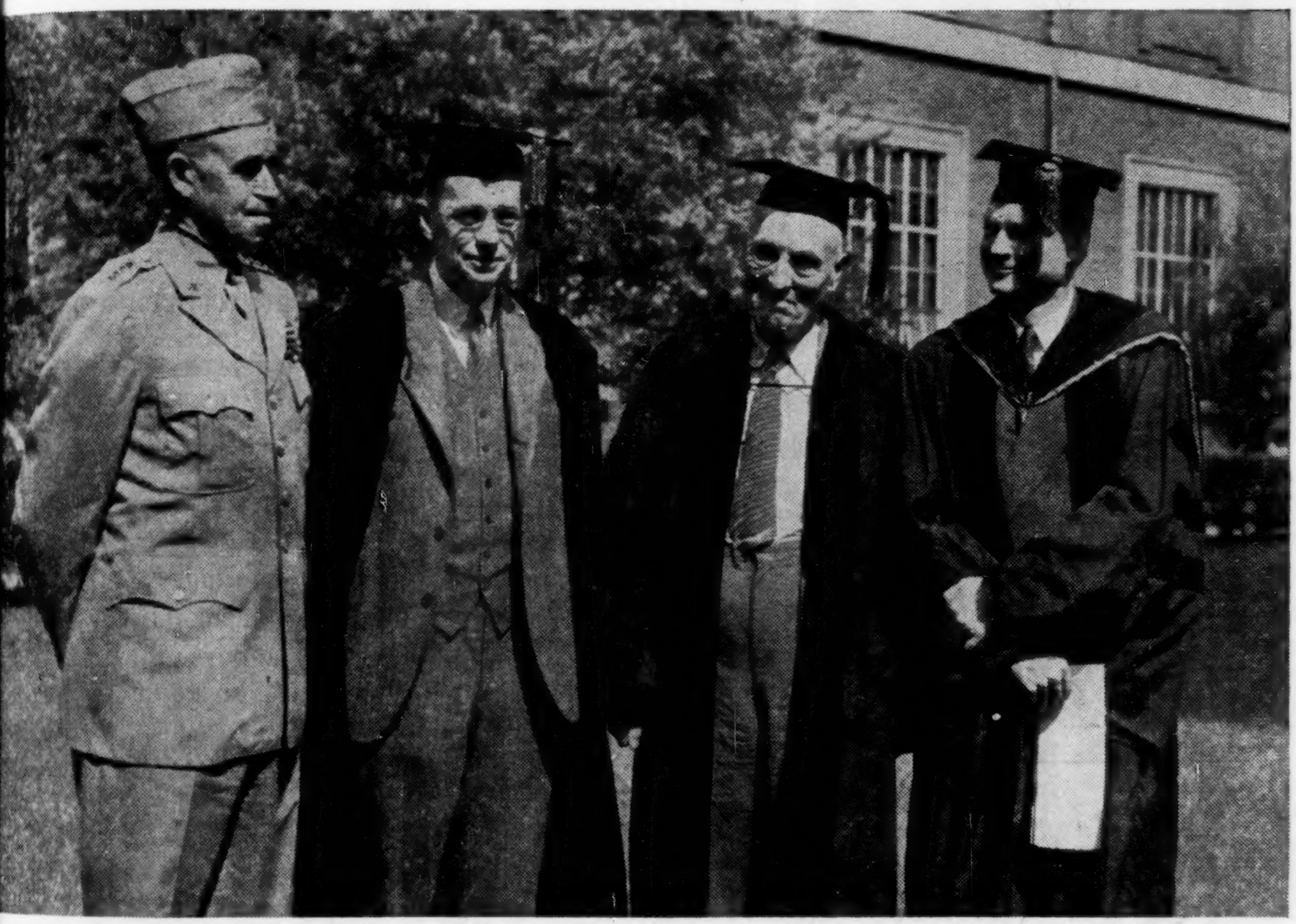

eneral Omar N. Bradley, U. S. Administrator of Veterans Affairs; James B. Conant, president of Harvard University; Anton J. Carlson, emeritus professor of physiology, University of Chicago; and President George D. oddard, pictured during ceremonies attending the installation of Dr. Stoddard as 10th head of the University Illinois, May 15-16. General Bradley and Drs. Conant and Carlson received honorary degrees from the University, along with Robert M. Hutchins, chancellor of the University of Chicago, and Archibald MacLeish, U. S. presentative on the Executive Board of UNESCO. (*University of Illinois Newsphoto.*)

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Union of Workers in the Biological Sciences

Robert F. Griggs, H. B. Tukey, and Ralph E. Cleland

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Science

CONTENTS

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Shall Biologists Set Up a National Institute?

Robert F. Griggs, *Chairman,*
Division of Biology and Agriculture, National Research Council, Washington, D. C.

THE PUBLIC RELATIONS OF THE biological sciences have been very much neglected, and today these sciences find themselves in much the same plight as did the physical sciences in 1930. The situation of the physicists at that time has been described as follows in a 1942 report of the American Institute of Physics:

> The (American) Institute (of Physics) had its origin in the pressing need for cooperation between the several American societies of physics, which need became apparent in 1930 and 1931 and was increasingly realized in the course of discussions held at that time between officers and committees of these societies. There were then operating these trends:
>
> 1. A notable and gratifying increase in American research activity calling for an increased number of pages in research journals without adequately increased income becoming available to pay the increased costs entailed. The financial condition of the journals was going from bad to worse.
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> 2. A growing tendency for physics to "split up."
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> * * *
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> No responsible person could contemplate these trends without grave concern. Must the results of research be inadequately reported or be suppressed through lack of funds? Must there be an increasing number of overlapping but unconnected societies for physicists to pay dues to? Would all of the profitable applications of physics appear under some other name, rendering no recognition and no financial support back to the parent science? Did these many groups have no common interests and objectives which they could attain better together than separately?

These words sound strange indeed to one acquainted with the present efficient way in which the American Institute of Physics looks after needs of physics and physicists.

I quote, by permission, from an unpublished paper discussing the present situation of physics:

> In 1931 voluntary officers, with a little secretarial help, could handle the needs of the members of the Societies and also speak for them in external matters. Our membership has since tripled. Our Societies are increasingly active. Moreover, the world has awakened to a recognition of the importance of our field of endeavor. Government agencies, national associations in many fields, the public press, educational institutions, industrial organizations, and others now press us for advice, cooperation, and an expression of the point of view of physics.
>
> Most of the problems presented are general, the interests of our Societies in them are identical and the Institute has come to be recognized as the representative agency to turn to. The future development of physics and the personal careers of physicists will be greatly affected for good or ill by what the Institute does. The load which would now have to be borne by the officers of the Societies, if the Institute did not exist, would be far too great for part-time attention. The harm which would result from uncoordinated and internally inconsistent representation of physics would be great.
>
> A specific example may serve to illuminate these generalized statements. It is important to physics to have a single, strong agency controlled only by physicists, to watch, and on occasion to advise concerning, the formulation of laws to govern the control of atomic energy, to extend federal support to research and education in science, and to provide for science in national defense or in world security. Such an agency is, then, needed vitally to watch, and advise concerning the administration of such laws by Government officials and on occasion to assist in their formulations and execution. With such an agency we can discharge our essential duty to society in these respects and, at the same time, ensure the free and vigorous advance of physics and improve the opportunities and facilities open to physicists for valuable and useful work.
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> To cite an example, the Institute made a study of shortages in scientific manpower. It introduced the conclusion into a report by Dr. Vannevar Bush to the President on which proposed legislation for a national science foundation was based, used the same conclusions to liberalize deferments and discharges from the armed services, and played the major role in establishing the pre-doctoral fellowships supported by a $550,000 grant from The Rockefeller Foundation. Only an authoritative, fully representative and efficient agency can hope for continuing success in enterprises of such magnitude.
>
> Such examples of course depict only a small part of the present work of the Institute and, taken alone, are insufficient correctly to represent its character.

We can have similar prestige and opportunity in biology if we will.

One of the most significant features of the change in the situation of physics is that the physical societies have been strengthened, and very greatly strengthened, by the activities of the Institute. That is because something new—something which was not attempted before—has been added. The same strengthening of the biological

This and the two following papers were among those presented before a Symposium on Proposed Plans for Union Involving Workers in the Biological Sciences, Section G, AAAS, Boston, December 27, 1946.

societies will occur if these societies get behind their institute as strongly as the physical societies are behind the Institute of Physics.

Lack of Public Appreciation of the Contributions of Biological Science to Victory

Everyone knows the major contributions of physics to victory—radar and the atomic bomb. But how many know that the contributions of biological science were of comparable importance? A physician with whom I recently talked showed great enthusiasm over the medical advances made during the war. When asked to name the most important, he answered: "Penicillin and DDT." Chemists have also claimed both these products as their contributions. I do not need to tell you that both are contributions of biology! In the research on penicillin and DDT, however, the top men controlling policy and appropriations were not biologists. There was not a single entomologist on the Insect Control Committee. True, biologists were called in as "hewers of wood and drawers of water." They had to be, for they alone were competent.

Failure of biologists to receive recognition for their work should be a matter of public concern, for the cost to this Nation of the absence of biological control over biological operations in the war was great. Rather early in the development of penicillin a biologist sought $20,000 to support research on improved strains of the organism. His application was rejected as impractical by OSRD. Later, WPB authorized this research—but only after expending several hundred thousand dollars on efforts in the same direction—and the productiveness of the organism was doubled. Biologists would have known that it was practical and, if in command, not only would have operated economically but would have made penicillin available to the public a year and a half sooner. No man can guess how many lives would have been saved if that project had gone through promptly.

But penicillin and DDT were not the largest contributions of biology to victory. "Food will win the war and write the peace" was a good and true slogan, though clumsily implemented. We could have won the war without penicillin or DDT, but we could have won neither war nor peace without hybrid corn, improved wheats, and other new varieties of crop plants developed by our plant breeders just in time for war needs. Without these improved crops, this country could not have supplied the food to support our armies, maintain our people at home at an efficiency unmatched elsewhere, and provide at the same time the tremendous stores of food sent to a devastated world.

Last year the United States shipped abroad more wheat than was ever before exported by any country in any year. This year's wheat crop again broke all records for production. In fact, each year since 1937 American food production has topped all previous records. This increased yield has resulted largely from improved varieties, the contribution of the plant breeders. But, for lack of proper advertising, there is little public recognition of the critical importance of the part that plant breeding played in our victory.

In the phrase of the physicists, a large proportion of the contributions of biology appears under some other name and neither renders recognition to, nor brings financial support to, the biological sciences. This is solely because the biologists are not organized so that they can do their job as a group. Until they are so organized, they will continue to work for others. *Biological operations need to be directed by biologists* just as surely as medical care must be directed by physicans.

Misuse of Biological Man Power in the War

During the war many strictly biological tasks were assigned to physicians, chemists, and similar personnel, simply because the authorities did not know what biologists could do or where they could be found. At the same time, hundreds of biologists worked under other names than their own. Because the authorities had no comprehension of their own needs from biology, many highly trained men in our fields were assigned low-grade jobs that anyone could have done. This occurred during the same period in which the Services were actively searching for the very men who were being denied the opportunity of using their training in the service of their country.

Bacteriologists in numbers, for example, were being put into the ranks and assigned to kitchen duty at a time when the Army was desperately trying to recruit bacterriologists for special duties—this because there was no national organization able to tell the Army what constituted a bacteriologist and where they could be found and to direct the members of that profession into places where their special skills would be utilized. It is only by such an able, vigilant organization that the Army could be made to see such situations and to provide for its own needs in the way of specialized personnel.

The contrast between the treatment of biologists and that of physicists by the Armed Forces was due to intelligent action by the American Institute of Physics. We need, the country needs, an American Institute of Biology.

When, because of ignorance of the country's real needs, the policies of Selective Service threatened to dissipate the Nation's reserve of scientific men, the National Research Council set up an Office of Scientific Personnel under the direction of M. H. Trytten. This office has been largely responsible for the considerable improvements that have been put into effect in Selective Service and in Civil Service procedures and especially for stopping the drafting of instructors and students in science.

The Office of Scientific Personnel was established through grants from scientific organizations: $3,000 from

the American Institute of Physics; $1,000 from the American Mathematical Association; $3,000 from the Geological Society of America. These grants have since been increased in amount, and the Chemical Society and the Psychological Association now also contribute.

When OSP was set up, I was asked: "Which biological society will contribute the additional $3,000 needed?" How would you have answered that? In the end, the National Academy of Sciences put up the biologists' share.

Need for Professional Organization of Biologists

Biologists are in a position very similar to that of a man drafted in a war. He may take the course of least resistance and remain a private, taking orders from everybody; or he may, by going to some trouble, become an officer and help to direct the course of events.

The biological sciences have been drafted into the national service. We cannot escape that. We may take command, or we may be commanded and do what we are told whether we like it or not. To take command, we must have an effective organization.

The Magnuson Bill seeking to set up a National Science Foundation made no mention of biology or agriculture except as biologists might be requisitioned into the service of medicine. Biologists of every kind were astonished that the public-spirited framers of a national science bill could be so blind to the Nation's need for biological research. Through the efforts of leading biologists, a division of biology was later included. No one should have been surprised that biology was omitted. Biologists have not made the public aware of the importance of biology.

An example of how self-advertising contributes to the public welfare and to the profession concerned is furnished by the recent rise of psychologists into positions of important public service. It is only within our own time that psychologists themselves have had any idea how useful they could be to a complex civilization.

Correct orientation of our civilization in line with the fundamental biology of ourselves and of the plants and animals with which we work is certainly as important to public welfare as are proper psychological services. Clearly, we must have organization, both to serve public needs and to develop our own professions. What kind of organization should this be? How shall we go about its formation?

A group including the presidents of the Union of Biological Societies and the American Biological Society has done much spade work toward promoting the establishment of an Institute of American Biologists. Their views were ably presented by Detlev W. Bronk to enthusiastic audiences last spring at the AAAS meeting in St. Louis and at the annual meeting of the Division of Biology and Agriculture of the National Research Council. Later, a group of 9 representative biologists requested the Division to survey the general problem. The remainder of this paper constitutes a report of such a survey.

Possible Courses of Action

In view of the preparatory work that has been done and the preliminary proposals that have been made for the establishment of an Institute of American Biologists, we face a series of alternatives:

(1) We can agree to set up an institute to serve the combined interests of all the professional people concerned with all of the animal and plant sciences.

(2) We can conclude that the fields of the various biological sciences are too diverse to be covered by any one institute and decide to set up two or more institutes.

(3) We can let this opportunity pass without action.

(4) We can undertake to set up an institute with the support of only a minority of the diverse kinds of biologists. One biological specialty might set up an institute purporting to cover the whole field of biology but really covering only one segment thereof.

For any group to be successful, a minimum budget of $20,000–$25,000 would be necessary. If we assume, as I believe we should, (1) that such organizations should, in the long run, be supported by their members and (2) that $10 per annum is about as much as the rank and file can be expected to pay, it is clear that, for success, groups of at least 2,000 must band together. Groups of 10,000, operating through a centralized administration, would probably be more than five times as strong as groups of 2,000.

The Society of American Foresters and the American Veterinary Medical Association, which alone among our groups have organizations rather closely comparable to the proposed institute, have memberships of approximately 5,000 and 7,500, respectively. The 1944 budget of the former, exclusive of publication costs, was $12,000 and including publication, $31,000; that of the American Veterinary Medical Association, a total of $75,000. The operating budget of the American Institute of Physics in in 1945 was $27,000, and the total was $90,000. This Institute has not, in the past, had individual members. The need of closer contact between the officers and the individual physicists became more and more apparent, and recently action has been taken to add individual members. The membership of its constituent societies totals about 8,000.

Can the Biological Sciences Be Divided Into Two Groups?

Many think that biology is too large a field to be included in one institute. Biology covers more ground and comprises more different kinds of scientists than any other major division of science, but examination of the

biological sciences makes manifest that they cannot be be dichotomously divided. Table 1 indicates an attempted separation of biological societies into two groups. There are, however, important segments of biology, such as cytology, genetics, and bacteriology, that are working more and more with both plant and animal materials and that cannot be listed under either group. These constitute a third, intermediate group. Let us examine the three groups of biological sciences in detail.

TABLE 1

Plant science societies		Societies looking toward both plant and animal science		Animal science societies		
Society	No. members*	Society	No. members*	Society	No. members*	Members by groups†
Phytopathological Society	1,130	American Genetic Association	3,530	Economic Entomologists	1,500	
Society of Agronomy	1,200	Society of Biological Chemistry	600	Entomological Society	970	2,000
Horticultural Science	740	Ecological Society	740			
Plant Physiologists	640	Genetics Society	560	Society of Mammalogists	950	
Botanical Society	1,380	Society of Bacteriologists	1,500	Ichthyol. & Herpetologists	570	
Mycological Society	380	Development & Growth	250	Limnological Society	380	2,000
Society of American Foresters	4,550			Wildlife Society	900	
Soil Science Society	500			Animal Ecologists	300	
				Physiological Society	770	
				Society of Biological Chemists	600	
				Pharmacol. & Exp. Therapeutics	280	
				Society for Experimental Pathology	290	3,000
				Institute of Nutrition	250	
				Association of Immunologists	250	
				Society of Zoologists	980	
				Society of Parasitologists	520	
				Dairy Science Association	1,350	
				Society of Animal Production	640	
				Poultry Science Association	540	10,000
				Veterinary Medical Association	7,000	
				Livestock Sanitary Association		
Totals	10,520		7,180			17,000

* Numbers are somewhat out of date and are rounded off.
† Numbers are approximate.

I. *Plant science group*. The plant sciences, over 10,000 strong, are a more homogeneous assemblage than either of the others. Yet there is reason to doubt that they would hang together in supporting a single organization.

The foresters (4,550) are already well organized and possibly would not see the advantage of joining with the other plant sciences in an organization whose objectives would be very similar to their own. There is, however, some reason to hope that they would affiliate with an institute speaking more broadly for all the biological sciences. The basis of this statement is the fact that forestry, standing alone, is somewhat isolated. The officers of the Society of American Foresters are, however, keenly aware of changing conditions that make cooperation of the sciences for public service imperative. An institute of biologists could expect the Society of American Foresters to join, but it would not expect a great percentage to take out individual memberships.

The balance of the plant sciences is a more compact and unified group than either the animal sciences or those with affiliation to both animal and plant sciences. Problems of considerable magnitude would be encountered, however, in binding the plant science societies into one unit. As a longtime officer of one of these societies has pointed out, more than one of these groups is essentially dual, comprising at once people whose primary interest is in one of the underlying basic sciences and others whose concern is entirely with practical application.

One might hope that each of the societies would affiliate and that the more scientific members of all of them would join an institute of plant sciences, but few of the more practical people might be expected to come in until the institute had demonstrated its usefulness to them. It would be difficult to guess how many members a plant science institute would lose for this reason, but there is certainly a large enough group of interested people remaining to exceed the 2,000 minimum necessary for such an establishment.

The remaining questions concerning an institute of plant sciences are: Are these groups really ready to proceed now? How shall they proceed? If they should start, are they prepared to follow through and bring their undertaking to a successful issue?

II. *Animal science group*. Aggregation of the animal sciences into a single organization would appear to offer far more of a problem than the accomplishment of such unification in the plant sciences. Some of the sources of disunity among the animal sciences seem to be the following:

(1) The entomologists, perhaps 2,000 strong, are closer to plant pathologists, agronomists, and horticulturists than they are to the Society of American Zoologists. They have rather uniformly chosen to hold their annual meetings in conjunction with the plant science groups.

(2) The field naturalists, another group of nearly 2,000, comprising the mammalogists, the herpetologists, the limnologists, the animal ecologists, and the wildlife specialists, differ widely by training, temperament, and outlook from the experimentalists.

(3) The group of about 3,000 which calls itself the Federation for Experimental Biology, *i.e.* American Physiological Society, American Society of Biological Chemists, American Society for Pharmacology and Experimental Therapeutics, American Society for Experimental Pathology, American Institute of Nutrition, American Association of Immunologists, has a strongly proclinical bent and finds its natural association largely, but by no means exclusively, with medicine. This very natural federation ought to be strengthened and developed beyond the stage of a forum for the presentation of research results, and of a common journal, into a strong national society similar to the engineering societies or to the American Medical Association.

(4) The groups concerned with farm animals, including the Dairy Science Association, the Society for Animal Production, and the Poultry Science Association, have more community of interest with agronomists than with zoologists. These three groups, together with the veterinarians and the U. S. Livestock Sanitary Association, have formed a loose federation of about 10,000 members to promote their common interests.

As to the original parent society of Section F, comparable to the Botanical Society of America in Section G, the Society of American Zoologists has not, in fact, maintained as broad and general a membership as has the Botanical Society, which for many years has successfully staged a "dinner for all botanists."

So far as an outsider can judge by duplicating memberships, etc., the largest fraction of the members of the American Society of Zoologists would probably be more interested in the Federation for Experimental Biology than in any of the other segments of animal science. A smaller number would be associated with the field naturalists, and the smallest fractions would find congenial surroundings among the sciences related to animal industry and entomology.

III. *Intermediate group*. After all the sciences dealing professedly with animal or plant material have been segregated, there remains a very important group of societies with approximately 7,000 members that frankly divides its interest as evenly as possible between animal and plant material. The members of this group, which includes geneticists, cytologists, biological chemists, ecologists, and the Society for the Study of Growth and Development, would be unhappy over the formation of separate institutes of plant and animal science but would welcome one institute binding all biologists together.

The 1,500 bacteriologists, although dealing unquestionably with plant material, would find less community of interest with the Botanical Society of America than with various medical groups or with societies associated with agriculture, such as the dairy scientists and plant pathologists. The microbiologists, among whom bacteriologists form the most numerous faction, are anxious to form a strong organization of their own but have not yet been able to produce a working institute. When they do so, they will greatly strengthen all biology.

It seems evident that separation of biologists into two groups, plant scientists and animal scientists, is not a satisfactory basis for segregating our groups and would not work well in practice.

I feel sure, therefore, that any unbiased study of the problem will lead to the conclusion that proper organization of the biological and agricultural sciences in this country demands the establishment of one over-all institute and half a dozen or more separate national groups concerned with the advancement of the biological sciences. Two of these groups are already organized and operating, namely, the American Veterinary Medical Association and the Society of American Foresters. Steps have been taken to strengthen the organization of entomology and to set up an institute in agronomy and related discipline. I hope these may bear fruit. We need others: one in plant science, pure and applied; one in entomology; one in proclinical experimental biology; one in microbiology; and one in animal production.

Such departmental organizations will, however, never be able to handle the public relations of biology as a whole, and at their best they could never have the necessary influence on public policies affecting biology.

Need for an Over-all Institute to Deal With Common Problems

Although we in the biological sciences are apt to consider ourselves zoologists, botanists, physiologists, bacteriologists, or some other type of specialist, the public with whom we must deal considers biology as *one* science, and whether we like it or not, we must deal with the public on that basis.

At the time we were working to have a division of biology added to the proposed National Science Foundation, some biologists felt that the Foundation would be more effective if two divisions, one in plant science

and another in animal science, were specified. I am sure, however, that those who have studied the long hearings on the bill will agree that it would have been impossible to have obtained the addition of two divisions in the biological field or to have secured recognition for any of the specialties to which we are devoted.

Our experience in allocating National Research Council Fellowships bears significant testimony to the impossibility of segmenting biology satisfactorily. Often, two applicants wish to work on essentially the same problem —one with plant material, the other with animal material. Should one arbitrarily be sent to a department of botany and the other to a department of zoology? In one type of problem, botanists may have made more progress, while in another, zoologists may be further advanced. It is therefore often advantageous to interchange men from one department to the other. A most interesting and important feature is that the proportion of applicants who cannot properly be segregated as botanists or as zoologists has increased markedly in recent years.

The relations of scientists to the public were changed by the war, and the orientation of science must be shifted to meet changed conditions. Briefly, the war brought home to the public, for the first time, the real importance of science. Science began in secret. It had to be kept out of sight of the bigoted leaders of the Middle Ages. The Royal Society of England, for a considerable period, was distinctly an underground organization that met in secret conclaves. With the granting of royal patronage, the classification of scientists in the public mind changed from "dangerous" to "harmless." Now the scientist is recognized for what, in truth, he is—indispensable to national security.

A national science policy is certainly going to be developed. The question before us is: Will the science of this Nation be guided by scientists who understand the needs of science or by laymen who do not? It is essential that scientists themselves organize and delegate some of their number, though it be only a small fraction, to look after the public relations of the scientific professions.

If it be granted that an over-all Institute of Biologists is needed, the practical question is: What shall we do now?

As the result of efforts of the group that sponsored the meeting in St. Louis, a committee widely representative of different kinds of biologists was recently called together to recommend further steps. The committee concluded that there ought to be an over-all institute for all biologists and requested the National Research Council to set up an institute within the Division of Biology and Agriculture. The Council will do anything it can to strengthen its service to biology and biologists. It would, however, be glad to be assured that the request of the committee has the backing of the national societies. The committee's resolution would be strengthened if each of the societies should similarly request the Council to set up such an institute.

The National Research Council is a cooperative association of scientists, as is the American Institute of Physics or the American Chemical Society, and, like them, it is managed and controlled by scientists. It has one great advantage over other scientific associations in that the importance of such an association was seen by the Government, and its formation was requested by an Executive Order of the President of the United States. A large majority of its members are elected by the scientific societies of the Nation. It has two further great advantages not possessed by any other scientific association:

(1) Covering all the fields of science, it can on occasion cross any of the boundaries that sometimes artifically separate scientific disciplines, and it can integrate all science.

(2) Because of its wide experience in administering grants from foundations and the confidence it has thereby inspired in donors of funds, it might be able to finance the new project more readily than could a group of independent biologists.

If it becomes clear that the biological societies and a substantial number of individual biologists will support the Institute, I believe I may say that the Council will attempt to underwrite it.

The most compelling reason for the immediate establishment of one over-all institute of American biologists remains yet to be given. The menace of atomic war is well advertised. It is so terrible that the physicists who know what it means have actively organized to forestall an atomic armament race; and they have gone far toward accomplishing their purpose.

It has been said, however, that if another war should come, it is more likely to be biological than atomic. There is no way to tell how much truth there may be in this statement. Let us hope there will be no war, but, war or no war, preparations for biological warfare are inescapably with us. It is clear that the very possibility of a biological war places an obligation on biologists to develop a considered collective consensus on the subject. That can be done solely by organized discussion such as is possible only through an institute.

A biological war could be far and away more terrible than an atomic war. Progress with the techniques of biological warfare has gone much further than most biologists realize. Although it has been stated that the "biggest research effort in the history of biology" was concerned with biological warfare—defensive as well as offensive—the public, and even the biological fraternity, has heard and thought little of the implication of biological warfare. Gerard Piel (*Life*, November 18, 1946) has stated: "There is as yet no body of responsible opinion on the subject of biological warfare. Formulation of such opinion cannot get under way too soon."

A more authoritative judgment to similar effect has been expressed by George W. Merck in an address at Pittsburgh. Mr. Merck was one of those entrusted, during the late conflict, with the guidance of this country's preparations for and against biological warfare. I quote:

> These investigations and the revelation of their inherent quality of producing not only weapons and defenses, but also fundamental advances of knowledge and practical contributions to medicine and agronomy, have necessitated *the writing of a new chapter in Biological Science.*
>
> * * *
>
> Those responsible for our defenses and preparedness in this upset world are alert; they have their programs ready. But they need support—support from scientists, academic and industrial, which should be given generously and in full measure—and it should not wait for an emergency call of patriotism.
>
> There must be support from the people through Congress and its proper committees. That means money for research. If anything is sure about such an investment, it is that it will pay large dividends—dividends for the nation's health and for the country's economy.

Shall biologists have any part to play in the formulation of public policy in biological warfare? We cannot do so as individuals. It must be a matter of group thinking and of group education. Biological warfare involves nearly every branch of plant and animal science: mycology, agronomy, animal husbandry, bacteriology, biochemistry, horticulture, entomology, ecology, mammalogy, veterinary medicine, physiology, both plant and animal. All biology must organize to lead the public in its thinking on biological matters.

Whatever our individual sciences may do to strengthen themselves in public service, it is clear that one over-all organization embracing all the biological sciences is essential *now.*

Research in Fundamental Biology and in Agriculture

H. B. Tukey, *Head,*

Department of Horticulture, Michigan State College, East Lansing

THE TIME IS RIPE FOR RE-EMPHASIS OF the fact that those in the fields of fundamental biology and agriculture derive many benefits from close association, and for calling attention to the opportunity they now have to work together in cooperation and mutual helpfulness to an unprecedented degree in the years immediately ahead. With the enactment by the Federal Government of the Hope-Flannagan measure, permitting appropriations of upwards of $9,500,000 for research in agriculture in 1947, with an increase each year to $61,000,000 in 1951, the way is open for development of a research program of a magnitude hardly yet fully understood or appreciated.

Speaking as one who has been concerned with problems of agriculture, specifically horticulture, I cannot pay enough tribute to the so-called fundamental field of biology for its contribution to the applied field. From the fundamental field comes the new approach, the revolutionary idea, the answer to many a practical problem. Much of the work of the applied field becomes involved in necessary service and in determining that one pound is as effective as two pounds. The basic or fundamental approach provides release from this routine. Added testimony to the contribution of the fundamental approach is the ever-increasing number of men in the applied field who seek training in basic subjects. In fact, in the field of horticulture the trend is to send students into the basic fields for a large part of their training, while maintaining seminars, reading rooms, and discussion groups to provide the horticultural point of view.

The close relation between biology and agriculture is implied in the definitions of the words themselves. Agriculture is "the cultivation of the soil for food products or any other useful or valuable growths of the field or garden," and biology is "the study of living matter." Just what "fundamental" means, as we use the word, is not so clear; I feel that we make altogether too much of it. As with moral codes, so with science: what is fundamental today is no longer so regarded tomorrow. If by fundamental we mean "essential" or "basic," then moisture is fundamental to tree growth, the tree is fundamental to the lumber industry, and lumber is fundamental to the carpenter. Only in the realm of an unsolved problem or an unprovided material does the word "essential" or "fundamental" seem to arise. Any new information is fundamental in the sense that sooner or later it is essential to something else. In fact, new and fundamental information is just as important to agriculture as are the products of agriculture to human welfare. We speak of the race between food supply and population, with famine as a possible outcome. We may as truly speak of the race between fundamental truths and the

advance of agriculture, with famine both of applied truths and of foodstuffs as the possible result.

We also use the word to distinguish pure science from what we call the "applied" field. But in this usage, to say that this or that is fundamental often means merely: "I do not yet see the application." Often only a little imagination is required to transpose a "fundamental problem" into an "applied problem." So much of the so-called fundamental has application that many of us, I fear, literally pirate fundamental biology.

Of course, in all of this there is nothing new, but it needs restating, especially to administrators in the applied field who are responsible for the direction of programs and for the allocation of funds for research in agricultural problems.

So much for the importance of fundamental biology to agriculture. What of the importance of agriculture to fundamental biology? In general, I believe, the applied field is in turn helpful to the fundamental field.

Although there are those who are strong enough and able enough to stand alone and work out problems without regard to others, those individuals are rare. Whether they prosper because of their isolation or in spite of it is a case for argument. There is good reason to believe, however, that, either consciously or unconsciously, most of us work on problems because we see in them some relation to our fellow man, either in the form of attaining recognition of intellectual achievement and acquiring special skills, added power, and prestige or in the form of giving service and help to human beings. The desire to be of service to others is basic in the human race and something from which, as individuals, we derive perhaps our greatest satisfactions in life. The tying of fundamental study to some practical or useful outlet is natural and satisfying.

Not only does association with an applied field make the application of a fundamental truth possible, but it may also materially speed its adoption and thereby increase and hasten the satisfaction to the individual concerned. The rapidity in application of work with growth regulators in preventing preharvest drop of fruit, in killing weeds, and in inhibiting sprouting of potatoes is an outstanding example in which the fundamental, the applied, and industry have succeeded as a triumvirate in pushing ahead where each alone could not proceed. Surely the fundamental has been aided by being tied to the applied field in this particular instance. Would we have had hybrid corn sooner if it had been developed in an applied laboratory? To be sure, it may be said that applied laboratories were working in this field but failed to grasp its significance. However, is this not more a matter of the individual involved than of fundamental or applied science? Many fundamental or basic truth have come from applied laboratories, and there will be more as administration sees the value of a liberal interpretation of both basic and applied problems.

It must be admitted, nevertheless, that there is danger of suppression and of stifling research through improper direction, and I think it is this sort of thing that workers in the fundamental field fear. In this connection it may not be out of the way to quote the remarks of C. E. K. Mees, director of research for the Eastman Kodak Company:

> Research is a gamble. It cannot be conducted according to the rules of efficiency engineering. . . Research must be lavish of ideas, money and time. The best advice that I can give is don't quit easily, don't trust anybody's judgment but your own; especially don't take any advice from any commercial person or financial expert, and, finally, if you really don't know what to do match for it. . . . The best person to decide what research work shall be done is the man who is doing the research. The next best is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director, who is probably wrong more than half the time. Then comes a committee, which is wrong most of the time. Finally there is the committee of company vice presidents, which is wrong all the time.

With most of that statement the majority of research workers will agree. Yet, to give the other side of the case, may not some of the difficulty lie with the research worker himself in not exercising sufficient imagination to tie his fundamental problem to the applied field? Cytogenetics may tie to breeding of a disease-resistant plant; photoperiod, to bolting of lettuce; tagged atoms, to controlling a virus trouble that threatens an industry; embryo culture, to producing a new rose or a cherry; and dormancy of seeds, to the nursery industry. To tie the fundamental to the applied is not a difficult task, but it is too often neglected. We forget that not many years ago a man labored half his life to become sufficiently independent financially to be able to carry on research. Nowadays the scientist is set aside by society to do this very thing. Is it too much to ask that we spend, say, 10 per cent of our time in harnessing our program to serviceable outlets? My experience is that not more than 10 per cent is required.

The applied field can bring financial support to research. Surely there is evidence that fundamental research has prospered when tied to the applied field. It seems to me that the loudest and most frequent pleas for financial assistance in the fundamental field are from those who have failed to tie to the applied field for support.

Closely related to financial support from the applied field is the encouragement that likewise springs from it. Man does not live by bread alone; neither does the research worker. Anyone who has experienced the enthusiastic support, encouragement, sympathy, and help that an applied field can provide will know what is meant. It is in many ways the most attractive feature of tying closely to the applied field.

Finally, the applied field offers specialists from dif-

ferent fields the opportunity to work together on the solution of a complex problem. We are in an age when the problems that can be solved by isolated individuals or groups are fewer and fewer. The era of cooperative attack is here. The applied field can provide both the specific problems around which specialists can rally to help each other and the means of support for an attack upon these problems.

It may be impertinent to ask whether a biologist really ever exists happily and successfully alone. It is probably not worth while to attempt to answer the question, but it may be worthy of passing comment. Like an active molecule, it is natural for a biologist to cleave to something. This does not destroy the usefulness or the value of a molecule; rather, it enhances its value. To be sure, there are molecules that exist uncombined with others, but it is the combined forms that are most helpful. Just so do biologists prosper when associated with or in symbiotic relation to medicine, plant and animal breeding, plant and animal pathology, agronomy, dairying, poultry husbandry, processing, canning, freezing, and scores of other fields.

Now we are approaching an era of public support for research such as that projected in the new Hope-Flannagan Act—support of gigantic proportions. Here is an opportunity and a challenge to both fundamental biology and agriculture. Agriculture needs the help of fundamental biology; without it, it will starve. Fundamental biology needs the support, the encouragement, the satisfying outlets, and the cooperative opportunities that agriculture can provide; without it, it may grow thin. Let us hope that a liberal attitude on the part of administrators in applied fields may prevail toward fundamental biology and that those in the fundamental field may find it attractive, worth while, and profitable to accept the encouragement, satisfaction, support, and opportunity for cooperative effort that the applied field can provide.

Possible Advantages of Cooperation Between Societies in Publication

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THERE SEEMS TO BE A RAPIDLY GROWING sentiment on the part of biologists toward some form of closer cooperation between the various societies—a sentiment based upon enlightened self-interest as well as upon a desire to contribute as fully as possible to the public welfare.

In the past, the tendency in biology has been toward disintegration. Those in the various fields of specialization have tended to work for the development of their own specialties to the neglect of the needs of biology as a whole. In so doing, they have failed to develop and support a more central and more general biological organization. One reason for this divisive tendency is the fact that biology is so diverse a field. The terminology and problems of one specialty are without meaning to many individuals in other specialties. There is not in biology, as there is in the fields of physics and chemistry, a large enough body of common knowledge and of common techniques to weld all biologists easily into a single, closely knit group. For this reason, biologists find it difficult to stick together; for this same reason, therefore, the need of cooperative effort and of organization is all the greater.

Although we biologists may speak many scientific languages, each being interested in matters unintelligible to many others, there is one thing that we all do in common. We all publish the results of our researches, and we all have to struggle with the problem of getting these results published promptly and economically.

That much can be done to increase the efficiency of our publications may be illustrated by reference to the situation I happen to know best—that of the *American Journal of Botany*. Financial reports of this journal from 1933 to date reveal some interesting facts. The average yearly income of the journal for the years 1936–44 was only slightly more than that for the years 1933–35, and the disbursements were only slightly less. We may say that these items have remained fairly constant. Nevertheless, with essentially the same income and expenses, the *American Journal of Botany* has, since 1936, achieved the following remarkable advances:

(1) It has increased its cash reserves 1,000 per cent.

(2) It has published, on the average, almost twice as much material per year since 1936 as in the years immediately preceding the reorganization (an average of 4,900,000 characters per annum vs. an average of 2,570,000).

(3) It has greatly decreased the time for publication of a paper, which averages at present between four and five months from date of receipt to date of publication, as

opposed to an average before 1936 of one and sometimes two years.

In short, with almost the same income and outgo, it has doubled its output, has reduced the time of publication to about one-fifth, and has increased its reserves by a factor of 10. This shows what can be accomplished when those who guide the destinies of a journal undertake to discover ways to increase its efficiency. Many other journals would, no doubt, benefit greatly by a similar study.

Dr. Griggs has kindly placed at my disposal a chart analyzing some 22 biological publications, plus a few general scientific or popular magazines, from the standpoint of efficiency of publication. A striking difference among the various journals in the list suggests that some journals may be printed more efficiently than others.

Let us consider, for example, the simple matter of the proportion of the page devoted to textual material. In *The Reader's Digest*, about 69 per cent of the page is occupied by printing; in *Time*, about 72 per cent. In one botanical publication, 67.1 per cent of the page is so occupied; in another, only 45.2 per cent. Then there is what Dr. Griggs calls the "index of economy"—the numbers of characters per unit area of page surface. The index for *Time* is 102; that for *The Reader's Digest*, 78.9. For one botanical journal it is 78.6; for another, it is only 43.8. One botanical journal thus has an "efficiency index" almost twice as high as that of another botanical journal. Obviously, much more remains to be accomplished in the direction of increased efficiency. These may be only minor items, since cost of paper is not of major importance in the total cost of publication. They suggest, however, the possibility that differences of greater importance exist among the various journals with respect to economy of publication.

It seems to me that development by various societies of a cooperative program of publication would be one of the best ways in which to bring about increased efficiency and to promote economy. I would suggest that such a joint program might involve two steps:

(1) A joint study might be undertaken of formats, typography, printing contracts, and other matters with a view to arriving at a plan that would result in maximum economy of publication with minimum fatigue to the reader.

(2) The societies might arrange to have their journals printed by the same firm, possibly under a joint contract. By standardization of printing specifications, the cost of printing could, no doubt, be greatly reduced. Consolidation of the business offices of these societies might result in further economies. Editorial policies would not be affected by such arrangements. Each society would continue, as at present, to control through its editorial board the rejection and selection of material.

I have seen correspondence between Dr. Griggs and a printer who, at the time of this correspondence, was publishing some 48 technical journals. It was the judgment of this printer that the joint publication of a group of journals with uniform format, typography, paper, and cover would save the participating journals up to 30 per cent in publishing costs. If the societies publishing these journals were also to give their accessory printing business to the same printer, the cost would be further reduced.

That this is not idle speculation is shown by the experience of the American Institute of Physics, which publishes 8 journals through a joint business office and a single printer. Some of these journals were losing large sums of money prior to the establishment of the Institute, but all are now in flourishing condition.

The possibility that biological journals could be published more economically by the cooperative effort of a number of societies should be thoroughly studied. It is only one of many advantages that might be derived from joint action, but it might prove to be one of the most tangible benefits to accrue from united effort.

What sort of cooperative organization might be set up to accomplish this and other benefits? Two proposals have been made for action on the part of botanists: (1) to establish an institute of botany; (2) to join in the organization of an American Institute of Biology. It is certain that botanical societies and botanists individually cannot support two such organizations. They will have to choose between them. If an institute of botanists were established, it would weaken an Institute of Biology if this were also set up. It might also result in the establishment of an "American Institute of Biology" that would include zoologists but not botanists—a situation that might prove to be very disadvantageous for the botanists.

It is my suggestion that the botanists do everything possible to aid in the studies which must precede the establishment of an American Institute of Biology; that they strive to bring out the sort of organization which will function most effectively in the furtherance of the work and welfare of both botany and zoology. If an Institute of Biology cannot be established on an effective basis, then will be the time to consider the formation of an American Institute of Botany.

Representatives from 27 national societies in the biological sciences, meeting together recently as an Organizing Board, have undertaken to solicit adherence to the American Institute of Biological Sciences from their respective societies as advocated, and the Institute is to be set up within the framework of the Division of Biology and Agriculture of the National Research Council, which is financing the preliminary Organization. H. B. Steinbach, Washington University, St. Louis, with headquarters at the NRC, is acting as executive Secretary during the period of organization.

NEWS
and Notes

The Senate passed the National cience Foundation Bill on May 20, 947. The bill passed was essentially .526 (*Science*, February 21, pp. 191–94) but with two major amendments. ne provides that 25 per cent of the unds will be distributed to tax-supported and land-grant colleges; the ther, that the Director of the Foundation will be appointed by the President of the United States instead of y the Executive Committee of the oundation.

Other amendments added specific rovision for research in cancer and ther medical fields, broadened ightly the field from which nominations for membership in the Foundaion will be secured, and altered ightly the wording of the tax proviions. These changes were adopted ithout opposition.

The Senate discussed the bill for our days. Most of this time was spent n debating amendments. Senator ilgore introduced an amendment alling for the distribution of at least 5 per cent of the funds to the states nd specifying that at least half of hat money be spent in tax-supported nd land-grant institutions; the other alf would be available to private olleges and universities. This amendment was defeated. Senator Morse hen introduced an amendment which lso provided that at least 25 per cent e distributed to the states but which iffered from the previous one in reuiring that all this money be spent n tax-supported and land-grant institutions. It further provided that wo-fifths of the 25 per cent be divided mong the states in equal shares and he remainder in proportion to popuation. In order to secure any money nder this provision, an institution must submit acceptable research proosals. Senator Morse's amendment, after considerable debate, passed by a vote of 42 to 40.

S. 526 originally authorized the President to appoint a National Science Foundation of 48 members. The Committee on Labor and Public Welfare reduced this number to 24. On the Senate floor an amendment which would have replaced the 24-member Foundation by a single Administrator was defeated. An amendment was then introduced by Senators Magnuson and Fulbright, giving the President power to appoint the Director as well as the Foundation. The Director would be appointed after consultation with the Foundation and would be subject to approval by the Senate. This amendment was frankly a compromise between two opposing points of view. One group believed that the Director should be appointed by, and be responsible to, the President; the other, that he should be selected by, and be responsible to, a large, independent board. The compromise expressed in the Magnuson-Fulbright amendment was proposed on May 1 by the Inter-Society Committee for a National Science Foundation and was supported by Senators Smith and Saltonstall as well as by its authors. It was strongly opposed by Senator Taft. This passed by a one-vote margin.

During the discussion of this amendment, two versions were considered. One gave both the President and the Foundation power to remove the Director. The other did not give that power to the Foundation. The version which was adopted gives removal power to the President, but not to the Foundation. Some of the Senators apparently were under the impression that they were voting for the other version. When the error was discovered, Senator Smith introduced a motion to reconsider, but later withdrew that motion. The press explained that he planned an attempt at giving the Foundation removal power when the House and Senate bills are brought together in conference.

An amendment creating a separate Division of Social Sciences, introduced by Senator Fulbright, failed to carry.

The final vote on the amended bill was 79 for to 8 against.

Scientists interested in the final adoption of science foundation legislation can now turn their attention to the House of Representatives. Its Committee on Interstate and Foreign Commerce held public hearings on science foundation bills on March 6 and 7. The next step necessary is for that Committee to submit a report recommending passage of the bill by the House of Representatives.

About People

Laurence H. Snyder, chairman of the Department of Zoology and Entomology, Ohio State University, delivered the Harry Burr Ferris Memorial Lecture at Yale University on April 30. His subject was "Principles of Gene Distribution in Human Populations."

William B. Davis, chairman, Department of Fish and Game, Texas A & M College, will head a group of 10 students in a cooperative study of an experimental deer range with the Colorado Fish and Game Commission near Meeker, Colorado, June 1–July 15.

Boris K. Likharev, paleontologist and member of the All-Union Geological Institute of the USSR, was honored at a special meeting of the Institute on March 20 upon the occasion of his 60th birthday and the 40th anniversary of his career in scientific research.

Llewelyn Williams, curator of economic botany, Chicago Natural History Museum, has returned to the Museum after a leave of absence of 15 months, devoted to the study of latex-yielding trees and to field trips in Mexico and the West Indies.

Knut Schmidt-Nielsen, research associate, Department of Zoology, Swarthmore College, has been appointed docent in biochemistry at the University of Oslo.

Van R. Potter, McArdle Memorial Cancer Research Laboratory, University of Wisconsin, recently presented a series of 10 lectures on the nature and activities of enzymes at the School of Medicine, University of Louisville, Kentucky.

O. E. Jennings and **E. R. Eller** were awarded the honorary degrees of LL.D.

and D.Sc., respectively, at the convocation of Waynesburg College, Pennsylvania, on February 24. Dr. Jennings is director, and Mr. Eller, curator of Invertebrate Paleontology, at Carnegie Museum, Pittsburgh.

Phillips M. Brooks, formerly with the Army Air Corps, where he conducted research in temperature tolerances and physiological hazards of high-altitude flight, has been appointed plant physiologist for the Natural Rubber Research Project at Salinas, which is conducted by the Stanford Research Institute under contract with the Office of Naval Research.

Visitors to U. S.

Plinio Rodriguez, of the Butantan Institute, São Paulo, Brazil, spent two weeks during April at the University of Texas Medical Branch, Galveston, to learn new methods of studying rickettsial diseases developed by Ludwik Anigstein. Dr. Rodriguez is visiting U. S. medical research centers under the auspices of the Coordinator of Inter-American Affairs, Washington, D. C.

Paul A. M. Dirac, Lucasian professor of mathematics, University of Cambridge, has been appointed visiting professor in the School of Mathematics, Institute for Advanced Study, Princeton, for the academic year beginning September 1947.

Grants and Awards

The American Society of Agronomy has established two new $500 annual awards for outstanding agronomy research from funds provided by W. H. Stevenson, vice-director of the Iowa Agricultural Experiment Station, and Mrs. Stevenson. Dr. Stevenson was head of the Department of Agronomy, Iowa State College, from 1910 to 1932, and has been vice-director of the Station for 35 years. He is also known for work as director of the Iowa Soil Survey.

The Massachusetts General Hospital Warren Triennial Prize for 1946 has been awarded to Paul C. Zamecnik and Fritz Lipmann for their essay, "Studies on *Cl. welchii* lecithinase," according to Joseph C. Aub, director, Cancer Commission of Harvard University, Massachusetts General Hospital, Boston.

Reuben Roseman, formerly of the 32nd General Hospital, U. S. Army, and at present with the Glidden Company, Baltimore, Maryland, has received the Bronze Medal of the University of Liége, Belgium, for aid rendered to the Bavière Hospital of the University during the war.

Scholarships

The John N. Derschug Memorial Scholarship in Engineering is to be founded at the College of Applied Science, Syracuse University, this fall. The annual scholarships will cover full tuition and expenses for complete courses in engineering given during the academic year. The fund for the scholarships has been provided by the Easy Washing Machine Corporation in honor of its founder, John N. Derschug.

Further details may be obtained from Dean Louis Mitchell, College of Applied Science, Syracuse University, Syracuse, New York.

Oklahoma Baptist University announces that 1947–48 graduate assistantships are available in the Departments of Geology, Biology, Chemistry, Home Economics, and Mathematics. Those interested may apply to John W. Raley, President, Oklahoma Baptist University, Shawnee, Oklahoma.

Colleges and Universities

A new photoelectric instrument, called a particle counter, has been developed in the Chemistry Department of Northwestern University. Announcement of the device was made by Frank T. Gucker, Jr., professor of chemistry, at the recent meeting of the American Chemical Society in Atlantic City, New Jersey. Collaborating with Prof. Gucker in developing the counter were: Chester T. O'Konski, research associate at Northwestern; Hugh B. Pickard, now assistant professor of chemistry, University of Maryland; and James N. Pitts, Jr., a candidate for the Ph.D. degree in chemistry at the University of California, Los Angeles.

The instrument, which automatically counts bacteria or smoke particles with diameters as small as 25 millionths of an inch and four millionths of a billionth of an ounce in weight, will be useful to the research bacteriologist in testing contamination and to industrial plants producing pharmaceuticals or chemicals by fermentation. According to Prof. Gucker, "the counter also may serve in detecting dust which must be excluded in the manufacture of photographic film and fine optical instruments."

The apparatus was designed and built originally under a contract with OSRD and improved under a subsequent contract with the Army Service Forces to test the filters of gas masks.

Summer Programs

The Ohio State University College of Agriculture will offer four new courses in fruit and vegetable technology beginning with the summer quarter on June 17. These courses have been designed to give students an opportunity to learn the beginning-to-end processing involved in the preservation, manufacture, quality control practices, and procedures used in fruit and vegetable canning, freezing, and dehydrating. Laboratory work will include inspection trips to food plants and the grading of preserved foods according to government standards.

Frederick C. Leonard, professor of astronomy, University of California, Los Angeles, will give a combined course in astronomy and meteoritics and a course in mathematics in the summer session of the University of New Mexico, Albuquerque, June 9–August 6. Dr. Leonard is a research associate of the Institute of Meteoritics, University of New Mexico.

Industrial Laboratories

Bausch & Lomb Optical Company has elected Ivan L. Nixon, manager of the Instrument Division, and Ben A. Ramaker, manager of the Ophthalmic Division, as vice-presidents. Re-elected were M. Herbert Eisenhart, president; Joseph F. Taylor, vice-president and treasurer; Carl L. Bausch, Theodore B. Drescher, and Carl S. Hallauer, vice-presidents; and Edmond S. LaRose, controller.

The Zemmer Company, Inc., Pittsburgh, Pennsylvania, has announced the appointment of Kenneth L. Waters as technical director. Formerly a pharmaceutical research specialist in Mellon Institute, Dr. Waters has been engaged in the revisional work of the new *U. S. Pharmacopoeia*.

Eastman Kodak Company has completed a giant aerial telephoto lens, built for the Army Air Forces. Designed for experimental aerial photography, the lens, measuring about a foot in diameter and four feet long and weighing about 125 pounds, has a 48-inch focal length, and

f/6.3 aperture, and a built-in heating system to conteract the effects of subzero temperatures at high altitudes. The new lens will permit large, sharp photographs to be taken from as much as a 10-mile altitude.

Eli Lilly and Company has appointed T. P. Carney head of the General Organic Chemical Research Department of the Lilly Research Laboratories. He was formerly with Reilly Tar and Chemical Company.

Elections

George B. Barbour, dean of the University of Cincinnati College of Liberal Arts, has been elected a corresponding member of the Royal Geographic Society of Belgium in recognition of his distinguished work in the field of geomorphology.

Harold Clayton Urey, director of the Institute of Nuclear Studies, University of Chicago, has been elected a foreign member of the Royal Society of London.

R. B. H. Gradwohl, director, Gradwohl Laboratories and Gradwohl School of Laboratory Technique, St. Louis, Missouri, was elected a Fellow of the Royal Society of Tropical Medicine and Hygiene, London, December 12.

E. E. Ecker, professor of immunology, Western Reserve University, has been elected Councillor of Honor, National Council on Scientific Investigations of Spain. Dr. Ecker, who recently returned from a tour of Europe, where he delivered a series of lectures on medical subjects, is also a member of the Royal Academy of Medicine of Spain.

Robert Cushman Murphy, American Museum of Natural History, New York, has been elected an honorary member of the California Academy of Sciences.

NRC News

Fellowships for research training in a number of scientific fields, including the applied sciences, are administered by the NRC. The support of these fellowships is derived from foundations, national societies, and industrial organizations.

The Merck Fellowship Board of the Council has awarded five fellowships for the year 1947–48, the first to be granted under a program established last November by a gift of $100,000 from Merck & Co., Inc. The purpose of these awards is to provide advanced training in the related fields of chemistry and biology and thus foster the development of scientific leaders with broad competence. In accepting this gift the chairman of the NRC pointed out that these fellowships will set a pattern for the more effective participation of American industry in the training of scientific personnel.

The high caliber of the 49 applicants for the awards is evidence of the wisdom and need of the Merck gift. From among the candidates the following were selected:

Joseph Lein, New York City, for a study of the specificity of enzymes produced by mutated and nonmutated genes in *Neurospora* at California Institute of Technology.

Lorin John Mullins, Palo Alto, California, to work at the Naples Zoological Station, Naples, Italy, on the experimental modification of permeability phenomena in marine vertebrates and invertebrates.

Arthur Beck Pardee, Pasadena, California, for work at the University of Wisconsin. He will conduct researches in general physiology, histology, cytology, and related fields, as preparation for a career in medical research.

B. Roger Ray, Nampa, Idaho, for work at the Rockefeller Institute for Medical Research on the determination of movements of salts through certain nonaqueous solutions by means of high-speed centrifugation, the results of which will apply to the problem of cell permeability.

Nevin Stewart Scrimshaw, Rochester, New York, for a biochemical study of factors associated with toxic complications of pregnancy and fetal abnormalities at the University of Rochester.

The Board which made these selections consisted of: A. N. Richards, University of Pennsylvania, chairman; George W. Beadle, California Institute of Technology; Hans T. Clarke, Columbia University; George O. Curme, Jr., Carbide and Carbon Chemicals Corporation; Rene J. Dubos, Rockefeller Institute for Medical Research; and Detlev W. Bronk, chairman of the NRC (*ex officio*).

Fellowships to promote fundamental research in the Natural Sciences are supported by a grant from the Rockefeller Foundation. These are awarded to young men and women who have demonstrated outstanding ability in research for the purpose of enabling them to gain further experience in conducting investigations at institutions which make adequate provision for effective prosecution of such work. Recipients of the 12 awards made for 1947–48 are:

Robert O. Bloomer, New York, to study the structure and stratigraphy of the Blue Ridge in Virginia, at Harvard University.

Gene B. Carpenter, Cambridge, Massachusetts, to work on an X-ray diffraction investigation of the solid forms of cyclohexane at California Institute of Technology.

John K. Galt, Portland, Oregon, to work on relaxation processes in ferromagnetic materials at the H. H. Wills Physical Laboratory, Bristol, England.

Bernard Hammermesh, a reappointment, to continue work at California Institute of Technology. His research will be on the mesotron energy spectrum.

Tong Hing, New York City, to conduct researches on normed rings and topological spaces at the Institute for Advanced Study.

John P. Hummel, Northfield, Minnesota, to conduct researches on a study of oxidative phosphorylation disturbances on myopathies at Wenner-Grens Institute, Stockholm, Sweden.

Edward S. Lewis, Weymouth, Massachusetts, to work at the University of California, Los Angeles, on the mechanism of the Sandmeyer reaction.

F. Harlan Lewis, Redlands, California, to conduct researches on a cytological study of the genus *Godetia* at the John Innes Horticultural Institute, London, England.

Herman Rubin, Chicago, Illinois, to conduct researches on systems of temporal stochastic equations at the Institute for Advanced Study.

Merle E. Tuberg, Rochester, Minnesota, a reappointment, to conduct researches on atomic structure calculations at Girton College, Cambridge, England.

Eugene C. Worman, Jr., Cambridge, Massachusetts, to conduct researches on the prehistoric and early historic cultures of India and their relations to others in the Near East and Far East, at Harvard University.

Daniel Zelinsky, Chicago, Illinois, to work on topological algebra of nonassociative systems at the Institute for Advanced Study.

The Board of Selection consisted of: Detlev W. Bronk, chairman, NRC;

Rollin T. Chamberlin, University of Chicago; M. H. Jacobs, University of Pennsylvania; Frank B. Jewett, National Academy of Sciences; Duncan A. MacInnes, Rockefeller Institute; and John C. Slater, Massachusetts Institute of Technology.

The Medical Fellowship Board is enabled, by a grant from the Rockefeller Foundation, to offer the National Research Fellowships in the Medical Sciences, designed to give special facilities for training and experience in research to persons who wish to devote themselves to an investigative career in the medical sciences. Such awards are intended for recent graduates who are not yet professionally established.

The Rockefeller Foundation has also provided the Council with funds in support of the Welch Fellowships in Internal Medicine. These are of senior grade and are intended to provide a prolonged period of advanced training for individuals of proven ability in research.

The National Foundation for Infantile Paralysis, Inc., has made available a grant in support of research fellowships in fields related to infantile paralysis. Under this appropriation, fellowships are offered (1) to provide opportunities for training and research in those basic medical sciences which will be of particular value in furthering progress in the field of orthopedic surgery and (2) for special experience in the study of virus diseases. Senior Fellowships in the fields of orthopedic surgery, pediatrics, and virus diseases, open to men and women who have already shown definite achievement in research, are also offered under this grant.

Fellowships in Anesthesiology, designed to give the candidate a year or more of experience in the sciences basic to anesthesiology, have been provided by a grant from the American Society of Anesthesiologists, Inc.

Twenty-eight new fellows received appointments for 1947–48, and 10 fellowships were renewed at meetings in March and April 1947. In addition, 7 fellows were granted three-year appointments to Welch or Senior Fellowships during 1946 and will therefore serve the second year of their terms during 1947–48. The 45 fellows holding appointments for the year 1947–48 are listed below:

Fellows in the Medical Sciences:

Forrest H. Adams, San Diego, California, to work in the field of pediatrics at the University of Minnesota.

Jerry K. Aikawa, Alameda, California, to study the pathological physiology of rheumatic fever at the University of California Medical School.

Rose G. Ames, Jackson Heights, New York, to study renal function in infancy at the Babies Hospital, New York City.

John M. Buchanan, Kalamazoo, Michigan, for work at the Nobel Institute, Stockholm, Sweden, on the isolation and purification of an iron-proteid substance found in milk (renewal).

Donald G. C. Clark, New Haven, Connecticut, to study the proteolysin inhibitor in mammalian blood at the Yale University School of Medicine.

Harry F. Colfer, Dillon, Montana, for correlative studies of the electrophysiology and the electrolyte equilibria of nerve cells at Cambridge University, Cambridge, England.

Robert H. Furman, Schenectady, New York, to study the physiology of coronary occlusion at Vanderbilt University School of Medicine.

Robert J. Glaser, St Louis, Missouri, to study the pathogenesis of the rheumatic diseases at Washington University School of Medicine, St. Louis.

Willard E. Goodwin, Montrose, California, to study prostatic and renal physiology at the Johns Hopkins Hospital, Baltimore, Maryland.

David G. Greene, Buffalo, New York, to study the pathological physiology of chronic pulmonary disease and of congenital heart disease at the College of Physicians and Surgeons, Columbia University.

Daniel L. Kline, New York City, for an *in vitro* study of hormonal influences in protein metabolism at Yale University School of Medicine.

Robert S. Knighton, Los Angeles, California, to study frontothalamic connections at the Montreal Neurological Institute.

Benjamin A. Levitan, Ottawa, Canada, to study the trophic effect of cholinergic drugs at McGill University, Montreal.

Herman C. Lichstein, Madison, Wisconsin, to study the amino acid metabolism of bacteria at Cornell University (renewal).

William F. Loomis, Tuxedo Park, New York, to study the enzymatic oxidations of the tricarboxylic acid cycle at Massachusetts General Hospital, Boston (renewal).

Gilbert H. Mudge, New York City, to study the lymphocidal and cytotoxic action of nitrogen mustard with comparison to radiotherapy at the College of Physicians and Surgeons, Columbia University.

Sanford L. Palay, Cleveland, Ohio, to study the localization of functions in the cell at the Rockefeller Institute for Medical Research, New York City.

Gifford B. Pinchot, Milford, Pennsylvania, to study the metabolic changes produced in the host by *B. tularense* infection at the Yale University School of Medicine (renewal).

Ernest Sachs, Jr., St. Louis, Missouri, to study autonomic representation in the cerebral cortex at Yale University School of Medicine.

Alvin L. Sellers, Los Angeles, California, to study the nature of vascular hypertension at the University of London Medical School, London, England.

Joseph R. Stern, Toronto, Canada, to study the intermediary metabolism of carbohydrate and of protein at the University of Sheffield, England.

Welch Fellows in Internal Medicine:

S. Howard Armstrong, Jr., Boston, Massachusetts, to study the interaction of proteins and small molecules of known biological and chemical specificity at the Massachusetts Institute of Technology (renewal).

James H. Baxter, Jr., Ashburn, Georgia, to study liver and kidney injury produced in rats by diets containing pyridine; location of work to be determined (second year).

John V. Taggart, New York City, to study the nature of enzyme systems in various disease states at the College of Physicians and Surgeons, Columbia University (second year).

Fellow in Orthopedic Surgery:

Thomas Gucker, III, Philadelphia, Pennsylvania, to study the circulation in normal and paralytic extremities at the Children's Hospital, Boston (renewal).

Fellows in the Field of Virus Diseases:

Harvey Blank, Chicago, Illinois, to study infection with the virus of herpes simplex at the University of Pennsylvania and at the Children's Hospital, Philadelphia.

Bernard A. Briody, Jr., Bethlehem, Pennsylvania, to study the interference phenomenon in filtrable viruses at the University of Michigan (renewal).

Fred M. Davenport, Greenwich, Connecticut, to study the etiology and

pathogenesis of acute infections of the respiratory tract at the Rockefeller Institute for Medical Research, New York City.

J. Lester McCallum, Avoca, Quebec, Canada, to study immunity in virus diseases at the University of Michigan.

Robert Rustigian, Medford, Massachusetts, to study the diagnosis of virus diseases at Harvard Medical School, Boston (renewal).

Duard L. Walker, San Francisco, California, to study the transmission of pneumotropic viruses at the Rockefeller Institute for Medical Research, New York City.

Senior Fellows in Pediatrics:

Gordon E. Gibbs, San Francisco, California, to study pancreatic disease in childhood at the University of California Hospital, San Francisco.

Victor A. Najjar, Baltimore, Maryland, for work on the purification of the enzyme phosphoglucomutase and study of its kinetics at the Washington University School of Medicine, St. Louis (renewal).

John L. Peck, Baltimore, Maryland, to study tissue antigens and antibodies in the pathogenesis of disease at the Johns Hopkins Hospital, Baltimore.

Edward L. Pratt, Boston, Massachusetts, to study water and electrolyte metabolism at Yale University School of Medicine (second year).

Alex J. Steigman, Philadelphia, Pennsylvania, to study the adaptation of human poliomyelitis viruses in mice of varying genetic constitution at the Children's Hospital Research Foundation, Cincinnati, Ohio.

James E. Ziegler, Jr., San Francisco, California, to study the chemistry of cellular enzymes at Yale University (second year).

Senior Fellows in the Field of Virus Diseases:

Martha B. Baylor, Chicago, Illinois, to study the genetics of tobacco mosaic virus at the Rockefeller Institute for Medical Research.

Lewis L. Coriell, Missoula, Montana, to study herpes simplex at the Children's Hospital of Philadelphia.

Harry A. Feldman, Washington, D. C., for work on the isolation of the measles virus and the development of the immune mechanisms and epidemiology of the disease at the Children's Hospital Research Foundation, Cincinnati, Ohio (second year).

Herbert R. Morgan, Riverside, California, to study methods for the isolation of viruses from contaminated materials at Thorndike Memorial Laboratory, Boston (second year).

John R. Neefe, Philadelphia, Pennsylvania, to study infectious hepatitis at the University of Pennsylvania (second year).

Frederick C. Robbins, Bronxville, New York, to study the epidemiology and possible viral etiology of infantile diarrheas and means of increasing the quantity of the viruses of the poliomyelitis group at the Children's Hospital, Boston.

Fellows in Anesthesiology:

Simpson S. Burke, Jr., Los Angeles, California, to study carbon dioxide absorption and analysis of nitrous oxide mixtures at the University of Wisconsin (renewal).

Margaret C. Pratt, Detroit, Michigan, to study the influence of pontine reticular nuclei on reflex response to anoxia and to make a comparative study of procedures for maintenance of oxygenation in pneumonectomy and occlusion of pulmonary vessels at McGill University, Montreal.

All of the fellowships listed above are administered by the Medical Fellowship Board, which is composed of: Robert F. Loeb, Columbia University, chairman; G. W. Beadle, California Institute of Technology; Alfred Blalock, Johns Hopkins University; Paul R. Cannon, University of Chicago; W. U. Gardner, Yale University; A. Baird Hastings, Harvard Medical School; T. Grier Miller, University of Pennsylvania; Homer W. Smith, New York University; A. Ashley Weech, University of Cincinnati; and John B. Youmans, University of Illinois.

A Norwegian-Swedish-British expedition to Antarctica is being planned for the autumn and winter of 1948, according to the American-Swedish News Exchange, Inc. Technical preparations for the expedition are in charge of Gen. Hjalmar Riiser-Larsen, an adviser with the Scandinavian Airlines System in Stockholm and former head of the Norwegian Air Corps, who will also lead the expedition if his advisory duties to the Airline permit. The scientific planning of the expedition is being handled by Hans W. Ahlmann, professor of geography, Stockholm University, who has led many Arctic expeditions and is known for his glaciological research. The landing party, as now planned, will include a geographer, biologist, meteorologist, and glaciologist from each country.

A 5,000-ton former German troopship, the "Svalbard," now belonging to Norway, will carry the party to Crown Princess Astrid Land, which will be the base of operation.

The American Institute for Research, Pittsburgh, incorporated last year as a nonprofit organization to carry out a research program in personnel psychology, is currently working on the problem of increased safety in commercial airline flying at the request of the Civil Aeronautics Administration. The project is being carried on under a contract with the Committee on Selection and Training of Aircraft Pilots, National Research Council. A critical analysis of the pilot's job is the immediate goal of the project. All relevant aspects of airline flying are being studied, and both the pilots' organization and the airline companies are cooperating with the Institute to insure representative results.

Other projects on which work is now in progress include the development of improved procedures for evaluating the efficiency of Army Air Force officers and the development of new types of aptitude and personality tests.

Although the main offices of the Institute are located in the Cathedral of Learning, University of Pittsburgh, there is no official connection with the University. Several members of the organization, however, hold appointments in the Department of Psychology.

Make Plans for—

The American Heart Association, Inc., annual meeting, June 6–8, Atlantic City, New Jersey.

American Society for the Study of Blood, organizational meeting, June 8, Hotel Claridge, Atlantic City. New Jersey.

American Institute of Electrical Engineers, summer general meeting, June 9–13, Montreal.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

American Society of Mechanical Engineers, wood industries national conference, June 12–13, Madison, Wisconsin.

COMMENTS
by Readers

A note in this journal (*Science*, 1946, **104,** 426) cautions against use of sulfuric acid-dichromate mixtures in cleaning glassware for microbiological experiments because of the possible toxic action of the traces of dichromate that often remain on or in the glass, even after repeated rinses. Figures showing retarded growth of various microorganisms and inhibition of enzyme systems in the presence of extremely low concentrations of dichromate are cited. In view of this note and the relatively high degree of toxicity generally attributed to chromium and dichromates, the following observation is of special interest, since it shows that under certain conditions traces of dichromate might also distort experimental results, not by exerting an inhibitory action but by causing stimulation.

During the course of a study of biosynthesis of penicillin by *Penicillium chrysogenum* X-1612 in shake flasks, we attempted to formulate the simplest synthetic medium, composed exclusively of compounds readily available in industrial quantities, that is capable of yielding reasonable concentrations of penicillin. It was found that chromium, furnished as $K_2Cr_2O_7$, was beneficial in this solution (*Science*, 1945, **102,** 482). We were interested to observe the necessity of adding Cr, and probably Al, for biosynthesis of penicillin in the basal synthetic medium where penicillin had to be synthesized from minerals, and from carbon supplied in the form of lactose, starch, glucose, and acetic acid.

Later experiments showed that when the concentration of Cr (supplied as $K_2Cr_2O_7$) was raised from 1 γ/l. to 20 γ/l., the maximum titer of penicillin in the crude liquor was increased from 50 Oxford units/ml. to about 85. Solutions containing 7.5 and 10 γ Cr/l. produced titers of about 70 and 75 units/ml., respectively. Solutions containing 100 γ Cr/l. yielded 85 units/ml., and those with as much as 200 γ Cr/l. permitted good growth of the mold and produced about 55 units of penicillin/ml. In these experiments the concentration of Al (furnished as Al acetate) was 3.6 γ/l. Virtually no penicillin was produced in the basal medium prepared with distilled water when no $K_2Cr_2O_7$ was added. The penicillin potencies were determined by the standard cylinder-plate method using *Staphylococcus aureus* NRRL 313 as the test organism and a standard of calcium penicillin G.

Strictly speaking, Cr and Al should not be designated "essential," since it has not been determined that no other elements can substitute satisfactorily for them. However, in our experiments penicillin could not be detected in the solution in their absence, and no other elements tested (Mo, Ce, Co, Ni) replaced them satisfactorily. This suggests that perhaps Cr and Al may be effective in catalyzing cyclizations and condensations involved in the biosynthesis of penicillin as they are in chemical synthesis (*Ind. eng. Chem.* (Ind. ed.), 1945, **37,** 356, 1038). The biocatalytic activity of Cr may be exerted through a stimulating effect on enzyme systems such as has been reported previously (*J. biol. Chem.*, 1939, **128,** 251). (ROBERTSON PRATT and JEAN DUFRENOY, *University of California College of Pharmacy, San Francisco.*)

Devotion of a rather large amount of space (*Science*, 1946, **104,** 373–374) to the description of what today may be fairly termed a relatively crude device suggests quite strongly that enough of our scientific colleagues bedeviled by the problems of circuit control are not fully oriented with modern resources.

Before the advent of modern relays I made many enforced practical studies on their lack of function, especially troublesome with heater circuits where thermostatic failure adds its contribution. Certain practical points garnered from years of experience may therefore be worthy of record for the benefit of those less interested in such matters. The key to accurate thermostatic control is a sensitive thermostat. This is almost inevitably associated with an inability to handle heavy currents, or sparking occurs at the contacts, leading to eventual failure. The natural corollary is that the associated relay must operate from small currents. In practice this should be less than 10 Ma. As a-c relays are now available, it is generally better to use them, since the sparking at contacts is less than an equivalent d-c load and consequently corrosion and sticking are minimized. Of the many and varied attempts to eliminate sparking at contacts, none has been entirely successful from a practical standpoint, in which expense is one real factor. Unless care is taken to match the circuit load correctly with the appropriate size of condenser, the use of these alone to suppress sparking may be quite unsatisfactory. In actual practice the condenser large enough to suppress nearly all visible sparking is too large, for its own charge, when released by contact closure, may be, and indeed often is, heavy enough to fuse the points and cause troublesome sticking.

For heavy loads such as heater circuits, I have found the use of a simple high-resistance bridge to be as effective and easier than the use of condensers. This is a small lamp that also has signal value. Where condensers are used, it is still advisable to use such a bridge so that they may be slowly discharged. This saves a good deal of contact "make" sticking. For a-c circuits a choke coil could be used. As the modern "wipe" silver contacts work well with heavy loads—5–10 amp. or more—the advantages of the more expensive, clumsy but sealed in, mercury contacts, except in very dusty or humid environments (stoker furnace controls) is now less apparent. Moreover, they will operate only at slow speeds, due to the internal sloshing of the mercury that may eventually set up a continuous arc. Their use inevitably leads to a bulkier apparatus. The mercury contacts are being replaced for many purposes by the remarkable little 4-ounce pressure switch, a highly sensitive switch operating off a slight pressure and short throw. These are admirably incorporated into relay controls and are also sealed in. They may be found operating the cheap but serviceable "brooder" thermostatic controls, as well as the more expensive room thermostats. The standard ones available

cost a few cents and will handle some 5 amp. at 115 volts (a-c).

For all ordinary purposes a visit to the local radio store will uncover a variety of relays (both a-c and d-c types), of quite remarkable sensitivity and endurance, costing in the order of $5.00 or less. A slightly more expensive instrument and one that I have found by experience to be an almost ideal laboratory tool, is the type 29XAX in the collection of fine relays made by Struthers-Dunn, of Philadelphia. This compact device operates on 5 Ma. at 115 a-c and is rated to carry 2 amp. at that same voltage. It actually carries heavier loads quite comfortably, providing circuit interruption is not too frequent. This type of relay has the advantage of working directly off the house current. If for some reason the high voltage is objectionable at the control point, a similar relay, wound for a lower voltage used with a step-down transformer, can be used. Both relays and transformers are now readily available and obviate very largely the use of batteries. (O. S. GIBBS, *1544–46 Netherwood, Memphis, Tennessee.*)

Reflection on the mechanism of action of chemotherapeutic drugs has led to the concept of specific bacterial enzyme inhibition. The exact mechanism of the inhibition is not yet known [see reviews by Henry (*Bact. Rev.*, 1943, **7**, 175), Frieden (*Texas Rep. Biol. Med.*, 1945, **3**, 569), and Mudd (*J. Bact.*, 1945, **49**, 527)].

Obligate intracellular organisms are dependent on some of the enzyme systems of the host cells, and their growth is affected and can be influenced by varying enzyme metabolism of the host cells. It has been shown by Greiff, Pinkerton, and Moragues (*J. exp. Med.*, 1944, **80**, 561) that rickettsial growth is depressed by the host cell enzyme activator, p-aminobenzoic acid (PABA). Presumably, the metabolic stimulation of the host cells by PABA makes it an unfavorable environment for rickettsial proliferation, which proceeds at an accelerated rate under conditions of lowered cellular metabolism as produced by sulfonamides, sodium fluoride, or deficiency of riboflavin.

For the control of rickettsial infections it is desirable to increase cell metabolism, inasmuch as rickettsial growth is increased in slowly metabolizing cells whether produced by vitamin, protein, or oxygen deficiencies or following radiation trauma. PABA has been found effective in endemic and epidemic typhus, Rocky Mountain spotted fever, and scrub typhus [see review by Anigstein and Bader (*Texas Rep. Biol. Med.*, 1946, **4**, 260)].

Sprunt (*J. exp. Med.*, 1942, **75**, 297) confirmed Rivers' clinical impression that vaccinia virus "is less able to multiply in the poorly nourished cells than in the well nourished one."

Foster, Jones, Henle, and Dorfman (*Proc. Soc. exp. Biol. Med.*, 1942, **51**, 215; *Science*, 1943, **97**, 207; *J. exp. Med.*, 1944, **79**, 221; 1944, **80**, 257) demonstrated that deaths from poliomyelitis virus (Lansing strain) and especially paralysis decreased in mice subjected to thiamine deficiency, restricted food intake, or both. Rassmussen, Waisman, Elvehjem, and Clark (*J. inf. Dis.*, 1944, **74**, 41) reported similar findings for the Lansing strain of poliomyelitis virus as well as for Theiler's virus. Presumably, the host cell metabolism (cocarboxylase) is so inhibited as to be insufficient to support poliomyelitis virus growth, although it seems to be sufficient for cell survival in most instances.

It seems to date that the therapeutic implications of these observations have not been sufficiently emphasized and investigated, although Mudd (*J. Bact.*, 1945, **49**, 527, footnote 2) implies the use suggested below. An attempt might be made to produce a vitamin (coenzyme) deficiency in the early stages of the disease which will make host cells an unsuitable environment for further virus proliferation. Possibly this is analogous to the action of sulfonamides in certain infections with the ornithosis and lymphogranuloma group of viruses (although a direct effect on the virus is difficult to exclude, since virus does not multiply demonstrably apart from living cells).

A thiamine deficiency may be produced by feeding such homologues as pyrithiamine, 2-n-butyl thiamine, or o-aminobenzyl-methyl thiazolium chloride. Possibly this deficiency in susceptible cells might be brought about rapidly, severely, and safely enough in the early stages of infection, thereby depressing further multiplication of poliomyelitis and possibly other neurotropic viruses (increasing "natural resistance") until the acquired immunity mechanisms are brought into operation.

Other intracellular infections might respond to vitamin-deficiency-producing drugs. It has been shown by Seeler and Ott (*J. inf. Dis.*, 1944, **75**, 175) that riboflavin deficiency in chickens produces lighter infections with *Plasmodium lophurae* malaria than in normal controls. In this case galactoflavin or isoriboflavin may be efficient in producing such riboflavin (flavoprotein dehydrogenase enzyme) deficiency. Mudd has also pointed to the structural similarity of riboflavin and atabrine, the antimalarial drug.

Some of the other vitamin antagonists (homologues, vitagonists) are pyridine-3-sulfonic acid and β-acetylpyridine for nicotinic acid; 4-desoxypyridoxine for pyridoxine; desthiobiotin, biotin-sulfone, and imidazolidone caproic acid for biotin; phenylpantothenone and pantoyltaurine for pantothenic acid; dicumarol, iodinine, and salicylic acid for vitamin K (see Woolley, *Science*, 1944, **100**, 579; *Adv. Enzymol.*, 1946, **6**, 129; Roblin, *Chem. Rev.*, 1946, **38**, 255).

Species differences with respect to the response to vitamin deficiencies have been observed. Rats could be protected against a hemolytic streptococcus by pantoyltaurine, whereas mice, whose blood pentothenate level is 5–10 times higher, could not be so protected (McIlwain and Hawkins, *Lancet*, 1943, **1**, 449). Thiamine deficiency did not significantly effect poliomyelitis infection (Lansing strain) in cotton rats (Weaver, *Amer. J. Dis. Child.*, 1946, **72**, 6), whereas mice were markedly protected by such deficiency. This is perhaps significant, inasmuch as the Lansing strain from primates must be passaged through cotton rats before it produces infection in mice. Perhaps the enzyme systems in the cotton rat and monkey support poliomyelitis virus proliferation more easily; there is a larger "margin of survival" with correspondingly decreased possibilities to effect a critical degree of inhibition.

The enzyme system of the host cells upon which each particular intracellular organism depends must be identified and inactivated by enzyme inhibitors. Metabolic studies such as those by Kabat and others (*J. exp. Med.*, 1944, **80**, 247; 1942, **76**, 579) may point the way. Host cell enzyme inactivation can be achieved biologically (virus interference) as well as chemically (vitagonists, amino acid homologues). Viral enzyme inactivation can be effected by penicillin and possibly sulfonamides. An approach along these lines, although hypothetical, may be in a promising direction. (J. K. FRENKEL, *University of California Medical School, San Francisco.*)

TECHNICAL PAPERS

Radiocarbon From Cosmic Radiation[1]

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It has recently been suggested (*2*) that neutrons produced by cosmic radiation should form radiocarbon by the reaction $N^{14}(n,p)C^{14}$ in such amounts that all carbon in living matter (and in other chemical forms in exchange equilibrium with atmospheric CO_2 on a 5,000-year time scale) should be radioactive to the extent of 1–10 disintegrations/minute/gram. In view of the 5,000-year half-life of radiocarbon (*3, 4*), it was further expected that it should be absent from such geologically "old" carbon sources as petroleum, coal, or limestone. The existence of such "cosmic radioelements" was anticipated by one of us (*1*) shortly after the discovery of artificial radioactivity.

These predictions were investigated by examining the radioactivity of two series of isotopically enriched samples of methane. The first series was derived from petroleum methane (referred to as petromethane) and the other from methane from the Patapsco Sewage Plant of the city of Baltimore (referred to as biomethane).

Measurements on the enriched biomethane samples established the activity of "living" carbon to be 10.5 disintegrations/minute/gram, in good agreement with the predicted value. On the other hand, enrichment of the petromethane by a factor of 25 failed to show activity beyond the limits of experimental error, in line with the theory that cosmic rays produce our activity.

The two methane thermal diffusion plants located at the Houdry Laboratories were used. Six hundred l. of biomethane were necessary to obtain about 20 l. of 12 per cent $C^{13}H_4$; these were purified in a high-vacuum system and reconcentrated to 65–70 per cent $C^{13}H_4$. Experimental values of $C^{13}H_4$ separation were used to determine the operating constants of the thermal diffusion columns. Upon extension of the separation theory to $C^{14}H_4$ concentration, the C^{14} enrichment was calculated, jointly with D. Tanguy, of Houdry's Special Projects Division, using these constants. The over-all error in the computed factor was probably about 20 per cent.

Possibilities of contamination were essentially excluded by running the plants and purification apparatus alternatively with bio- and petromethane, as indicated by the take-off dates of Table 1.

The samples were measured in a brass-cylinder Geiger counter, with glass heads, of 1,900-cc. volume, surrounded by 1.5-inch-thick lead shield to reduce the background. Alternate readings were taken at 6.5 cm. Hg pressure with the two series of samples. A standard external sample of U_3O_8 was used to check that the counter sensitivity was the same for all fillings.

TABLE 1

Source	Sample No.	Calculated C^{14} enrichment	C^{13} concentration from mass spectrometer (%)	% CH_4 in gas before final purification	Date taken	Total count rate, including background (disintegrations/minute)
Petromethane	I	1	1.04	99.6	10/16/46	340.6 ±1.0
	II	1	1.04	99.6	"	342.6 ±1.0
	III	25	6.55	97.2	1/ 6/47	345.8 ±1.3
Biomethane	III	1	1.04	99.4	12/ 5/46	342.9 ±2.0
	I	10	7.36	93.6	10/17/46	348.7 ±1.3
	VII	32	11.02	99.9	12/ 2/46	364.0 ±1.5
	VIII	260	63.5	97.2	2/10/47	562.0 ±2.9

Our data are given in Table 1. There is no significant activity in the petromethane, whereas the biomethane has a definite, easily measurable activity increasing linearly with the calculated C^{14} enrichment.

To eliminate the possibility that the activity was due to tritium, the most concentrated methane, sample Bio VIII was burned and converted to $CaCO_3$. The activity of the $CaCO_3$, as measured in a screen wall counter, established the radioactivity as carbon rather than hydrogen. Further identification of this radioactivity was obtained by a measurement of its absorption in aluminum, which agreed with that of synthetic C^{14}. The data thus establish the activity as being carried in carbon in a molecule of mass 18, present in the original biomethane in very low concentration. The agreement of the absorption data with those for C^{14} further confirms the identification of the activity with C^{14}.

The possibility that the C^{14} found in Baltimore sewage is due to contamination is not entirely excluded, although it is remote. Our sample was taken on September 2, 1946, at which time, according to P. C. Aebersold, no C^{14} from the Atomic Energy Commission had been received by anyone in Baltimore. The possibility of its origin from the atomic piles or bombs is excluded when one realizes that our activity corresponds to the existence in nature of some 10^8 curies, or 20 metric tons—an amount far larger than any synthetic source could have produced to date.

The discovery of cosmic-ray carbon has a number of interesting implications in the biological, geological, and meteorological fields; a number of these are being explored, particularly

[1] The authors are grateful to George E. Finck and R. J. Trautman, Department of Public Works of the city of Baltimore, to H. G. Swope, secretary of the A.C.S. Committee on Water, Sewage, and Sanitation, and to Abel Wolman, Johns Hopkins University, for their cooperation; to the Sun Oil Company for the use of its thermal diffusion columns; to W. H. Johnston for assistance in the counting measurements; and to J. T. Dooley for technical assistance.

the determination of ages of various carbonaceous materials in the range of 1,000–30,000 years.

This investigation is continuing with other sources of carbon and is being extended to other possible cosmic radioelements. A more detailed report will be published elsewhere.

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Fowl Spirochetosis Transmitted by *Argas persicus* (Oken), 1818 From Texas[1]

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Hoffman, Jackson, and Rucker (*4*) have given a preliminary report of spirochetosis in turkeys in California in which no vector was found, although a careful search was made in all poultry houses. This spirochetosis manifested itself in a mild nature compared with that reported by various investigators in other parts of the world. The symptoms were: standing or sitting with the eyes shut, anorexia, loss of weight, and diarrhea. More severe cases walked with difficulty. In a later paper, Hoffman and Jackson (*3*) reported the pathological effects of the spirochete in fowl. The epizootiology of the disease in the flock remained unknown.

Steinhaus (*7*) reported the isolation of an unidentified spirochete from hen's eggs after inoculation with liver tissue from hens raised in Montana. This spirochete was not pathogenic for chickens—a fact which may indicate a difference from the known infectious agent of fowl spirochetosis.

Marchoux and Salimbeni (*6*) showed that the common fowl tick, *Argas persicus*, is a vector of *Borrelia anserina* (Sakharoff) (= *Spirochaeta gallinarum* Blanchard), the agent of fowl spirochetosis. This was verified by the work of Balfour (*1*) and others. The spirochete is transmitted to the progeny of an infected tick through the egg. Incubation in the fowl, when tick transmitted, takes 4–9 days before spirochetes are demonstrable in the peripheral blood. Recovery from the disease is followed by lasting immunity, but in some outbreaks in the Old World the case fatality has been from 60–90 per cent.

Cooley and Kohls (*2*) report *Argas persicus* of almost worldwide distribution in warm climates and a vector of avian spirochetosis in many Old World regions and in Brazil, Panama, and Cuba in the New World. Hungerford and Hart (*5*) showed that the common red mite of chickens (*Dermanyssus gallinae*) can serve as a vector of the fowl spirochetosis.

In the present studies a white Leghorn rooster, on which a large number of ticks obtained from a poultry raiser in El Paso, Texas, were being maintained, became very ill. Blood smears were not made at first, and later they were negative for parasites. Several hundred progeny from these ticks and a few unfed nymphs and adults were next fed on a white Leghorn pullet. A blood smear from the normal hen was negative with Giemsa stain. In 6 days the pullet was obviously ill, and blood smears were positive for spirochetes. On the 7th day many spirochetes were present in blood smears, and a few were still present in the peripheral circulation on the 8th day. After the 8th day no spirochetes were found in blood smears.

Symptoms of the spirochetosis were: jaundice, anorexia, and diarrhea, with loss of weight. The rooster exhibited symptoms of partial paralysis. Both birds tended to sit and droop the head with the eyes shut. Recovery was uneventful in each case. It is believed that this is the first finding of tick-borne avian spirochetosis in the United States.

[1] Paper No. 2338, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul.

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A Growth Inhibitor and a Growth Promotor in Sugar Cane[1]

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In connection with a study of structural development in sugar cane, a series of investigations was begun on the growth-regulating substances produced by that plant. In order to find a method by means of which the substances from all tissues of the plant, chlorophyllous as well as nonchlorophyllous, would be extracted, several methods of extraction and analysis described in the literature were tried. The results were unsatisfactory, however. When the direct ether extraction method of Boysen-Jensen was used, the chlorophylls, easily extracted from the green tissues of sugar cane, caused undesirable coagula which interfered with the accurate assay of growth substance in the *Avena* test. Van Overbeek, *et al.* (*10, 11*) applied this method to node and internode tissue of sugar cane stem, where apparently little or no chlorophyll was extracted. Furthermore, in all instances in which tissue was extracted with ether or with water, the sets of coleoptiles showed mixtures of curvatures, some positive toward the agar block and some negative. Since it was thought that such curvatures could not be averaged to give results of any significance, a series of experiments was begun to determine the source of the positive curvatures.

The presence in plants of substances which prevent the

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growth of the *Avena* coleoptile and cause positive curvatures in the *Avena* assay has long been suspected, but only in relatively recent years have direct evidences of the production of at least one substance been obtained. These evidences indicate that growth-inhibiting substances are produced in a large number of plants and perhaps in all plants. They seem to be produced in quantities varying in relation to the quantities of growth-promoting substances; they may cause little or great interference in growth substance assays and may easily be overlooked when present in small quantities.

Goodwin (*4*) reported evidence for the presence of inhibiting substances in ether extracts of plant tissue. Diffusion coefficients of auxins extracted by ether did not agree with the theoretical coefficient for auxin a or b. He concluded that this discrepancy was due not to an auxin of different molecular weight but to substances which partially masked the biological effect of auxin on the *Avena* coleoptile.

Stewart (*9*) found a substance in the cotyledons of radish plants which caused positive curvatures of oat coleoptiles. The inhibitor reduced the degree of negative curvatures when extracts of it were mixed with 3-indole acetic acid. Stewart concluded that the *Avena* test would give curvatures that would be correct measures of neither auxin nor inhibitor if both were present in the extract.

Van Overbeek (*10*), using direct ether extraction of nodal and internodal tissue of sugar cane, found that heating tissues in boiling water caused the liberation of a substance that had an inhibitory effect on the curvature of the *Avena* coleoptile. Fresh tissue frozen with solid carbon dioxide and then extracted with ether appeared not to yield the inhibitor.

Because Avery, Berger, and White (*1*) and Shalucha (*8*) have been able to obtain high yields of growth-promoting substance from several kinds of plants with the use of aqueous extraction of lyophilized leaf tissue, and because DuBuy (*3*) obtained good results with water extracts of tissue frozen with solid CO_2, it was decided to try water as primary extractant. It was decided also to attempt two ether extractions, one from neutralized water extract and another subsequent one from the same water extract acidified. A single test on ether extraction from acidulated distilled water yielded a majority of positive curvatures in our sets of coleoptiles. At about this time Larsen (*7*) published the results of his work leading to the identification of 3-indole acetaldehyde as a neutral growth substance, inactive in the *Avena* test, that could be converted to 3-indole acetic acid by action of soil or of the Schardinger enzyme of milk.

The method now used, after several modifications, is given below. No experiments to determine the thoroughness of extraction have been performed, nor have attempts to identify the substance been made. The data are presented as averages of degrees of curvatures of the coleoptiles and are to be considered at this stage of the investigation as qualitative only.

Materials and Methods

The plant material used was taken from nodal and internodal tissue and young leaves of a sugar cane hybrid.[2] Stem material consisted of internodes within or, in some experiments, just below the spindle cluster. Leaf material was comprised of blade tissue of leaves 3, 4, and 5, numbering from the first visible leaf of the spindle cluster (numbering method of Clements, *2*).

The "deseeded" *Avena* assay method of Skoog was used, with two decapitations and a 5-hour photographing period. All work with the coleoptiles proceeded in a specially constructed dark room in which temperature was maintained at 25°–26°C. and relative humidity at 90–91 per cent. Light was supplied by neon in ruby glass tubing mounted over the work table. This provided bright red light of wave lengths above 6,000 A.

The first experiments were carried out utilizing only 50 or 100 mg. of fresh tissue. This quantity was increased weekly until a sample of 200 grams of fresh weight produced significant curvatures in the *Avena* test. All subsequent extractions were made on 200 grams of fresh tissue. The tissue was treated as follows:

(1) The sample, of green or of nonchlorophyllous tissue, was cut as rapidly as possible into pieces 4 mm. or less on a side. The cutting process was performed on a slab of solid CO_2, which not only accomplishes quick freezing but also facilitates cutting succulent tissue.

(2) The sample was separated into approximately equal quantities, each quantity then being placed in dry ice and kept in the frozen state for approximately 20 hours. The quick freezing seemed to facilitate extraction of the growth substances.

(3) The jars were opened, the frozen tissue covered with distilled water (pH 5.5) at room temperature, and the sample muddled with a glass pestle or thick stirring rod, a few small pieces of dry ice being added from time to time to create a carbon dioxide atmosphere. This ostensibly reduces the chances of possibly undesirable oxidation. It also markedly reduces the tendency of the tannins to oxidize to pigmented compounds, and the water is agitated by the bubbling of the CO_2 gas, thereby effecting a constant stirring.

(4) After two hours the water was decanted into a Buchner funnel, and more distilled water was put on the sample and allowed to extract for one-half hour more. The water was decanted into a Buchner funnel, and the residue was washed once, squeezed by hand through a double thickness of cheese cloth, and placed in another sample bottle for further treatment as desired.

(5) The water extract was filtered in several flasks, the number depending upon the volume of water. With the large samples used in these experiments the water extract was usually between 800 and 1,000 ml. in volume when the filtrates were combined and the flasks rinsed with distilled water.

(6) The water extract was then neutralized with 8 per cent (saturated) $NaHCO_3$ solution. No glucose was added because of the high sucrose content naturally resulting from the cane tissue. Between 5 and 10 ml. of bicarbonate is usually sufficient, and the solution, when checked with the Macbeth pH meter, reads pH 7–7.3.

(7) The neutralized extract was placed in separatory funnels and covered with approximately equal volumes of freshly distilled diethyl ether. Emulsifying substances, usually finely suspended particles of tissue, were sometimes included in the water extract, necessitating use of a swirling motion and avoidance of shaking. It is often unavoidable that a coagulum

[2] *Saccharum officinarum* variety H-32-8560 crossed with unknown pollen. The seedlings were supplied through the courtesy of A. J. Mangelsdorf, Experiment Station, Hawaii Sugar Planters' Association.

containing ether results; when this occurred, the coagulum, which formed on top of the ether layer, was drawn off last and centrifuged to remove ether. The centrifuged residue was washed again with ether and the ether added to the larger ether extract. After the water was drawn off, the ether was allowed to run into a beaker. The water was then put back to the separating funnel and the process repeated. After a third repetition, the three ether extracts were combined, making the neutral fraction.

(8) To the water, which increases somewhat in volume by solution of some ether, was added, with stirring, a quantity of 15 per cent tartaric acid. The electrodes of the pH meter were kept in the extract, acid being added until pH 4 was reached. The water extract was then ether-treated as described in (7).

(9) Each ether extract was evaporated to 1 ml. in water by placing the beaker on a hot plate with very low heat and directing the current of air from an electric fan across the open top. During evaporation the ether was transferred successively into small beakers and finally into shell vials marked for 1-ml. volume. Each beaker was rinsed with a small quantity of ether. If there was not enough residual water, distilled water was added to make a volume of 1 ml.

(10) The 1-ml. extracts were combined in the vials with 1 ml. of 3 per cent agar, warmed sufficiently to be fluid, the solution then being mixed by gentle shaking and poured into a mold, constructed (of glass microscope slides glued to a lantern slide glass) to permit adjustment of the agar level to a 2-mm. depth. Rectangles of the gelled agar were cut in the cutting frame with a razor blade into cubes of 8-mm.^{3} volume, for use in the *Avena* test.

Results

In all experiments in which this procedure was followed, mixtures of significant curvatures were obtained. Representative results are given in Tables 1 and 2.

TABLE 1

Curvatures Obtained With 200 Grams Fresh Sugar Cane Stem Immediately Below Spindle Cluster*

	No. of coleoptiles	Degrees maximum curvature	Degrees minimum curvature	Average
Experiment 1				
Acid fraction	12	+9	+3	+6.7
Neutral fraction	12	−23	−4	−9.3
Experiment 2				
Acid fraction	14	+24	+6	+13.7
Neutral fraction	17	−11	−2	− 4.2
Experiment 3†				
Acid fraction	22	+8	+2	+ 4.8
Neutral fraction	24	−21	−7	−12.4

* Different samples of sugar cane of mixed and various ancestry were used in each experiment. The data may therefore not be comparable.

† Part of an experiment with young stem tissue.

Although no other tests were made to substantiate the data of Table 2, it appears that with the material used there is evidence of a much greater amount of inhibitor than of growth promotor. These tissues were obtained from upright, growing sugar cane with dormant axillaries. No tests have been made with regard to thorough or prolonged extraction, and the assumption that our data represent extraction of free growth substances is based upon the results of Van Overbeek's experiments (*10*), where it appears that most of the free auxins "are extracted within the first half-hour."

The growth-inhibiting substances in Table 1 are in approximately the same concentration as those in Table 2, but the growth-promoting substances are in much greater quantity than indicated in Table 2; and in Table 1 (Experiments 1 and 3) the growth-promoting substances are in greater concentration than the growth inhibitors in the same plant material.

Conclusions

No attempts have been made to report these data on bases of total degrees curvature, indole acetic acid equivalents, or any of the other units found in the literature. The method used is not yet developed to the stage where accurate, reproducible results may be obtained. It is our opinion that until a better knowledge is gained of the substances being dealt with in sugar cane, reporting of results on a quantitative basis has little significance. The material used to date was taken from hybrid cane the male parent of which is not known; the stand is therefore made up of many strains, often evidenced by distinct color differences, hairiness, and other superficial characters. The quantity of growth substances may vary among plants, and the relative proportion of the two kinds may vary within the plants. Future studies will be made upon plants of one variety.

TABLE 2

Curvatures Obtained With 200 Grams Internode, Root Band, and Intercalary Meristem Tissues of Sugar Cane

Tissue	Fraction	No. of coleoptiles	Degrees maximum curvature	Degrees minimum curvature	Average
Internode	Acid	18	+9	+3	+4.7
	Neutral	22	−7	−1	−3.1
Root band	Acid	19	+15	+2	+6.2
	Neutral	15	−5	−1	−1.6
Intercalary meristem	Acid	14	+6	+2	+3.6
	Neutral	18	−4	−1	−2.4

The growth substances of a plant form a complex system not analyzable by a simple procedure. At least three groups or categories are now known. These are: (1) growth-promoting substances, which produce negative curvatures in the *Avena* test. Auxenolonic acid, auxentriolic acid, and 3-indole acetic acid are known to be produced in higher plants; (2) neutral growth substances, the presence of which in plants has been demonstrated by Larsen (*6, 7*) who identified one as 3-indole acetaldehyde and has evidence that this substance, inactive in the *Avena* test, is converted by aldehydrases to 3-indole acetic acid; and (3) growth-inhibiting substances, which produce positive curvatures in the *Avena* test. Presence of this kind of growth substance has been demonstrated by Larsen (*6*), Kisser (*5*), Stewart (*9*), and others in tissue which apparently was relatively low in growth-promoting substances. The nature of these compounds, or their relationship to the others, is not yet known, but Stewart (*9*) presents evidence indicating that the inhibitor of radish cotyledons may be hydrolyzed to growth-promoting substance.

It is clear, then, that a satisfactory extraction technique must somewhere provide for the separation of the *two* groups of growth substances which are active in the *Avena* test. Unless this is done, the *Avena* assay can only approach reasonable accuracy when either group of substances is extremely low in relation to the other.

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Comparative Nutritive Value of Casein and Lactalbumin for Man

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The classic work of Osborne and Mendel (*5*) showed that casein is deficient in cystine and that its companion protein, lactalbumin, is superior in promoting the growth of rats. This finding was promptly (and at that time, perhaps, properly) used in partial explanation of the superiority of breast milk over cow's milk in the feeding of infants (*2*). In confirmation of these early observations, we have recently reported (*1*) that the addition of methionine to an enzymic hydrolysate of casein (amigen) resulted in an accelerated rate of growth in rats, and when the supplemented hydrolysate was given intravenously, it improved nitrogen retention in dogs. When the same type of supplementation studies were made in humans, there was no improvement in nitrogen retention. Four groups of humans were employed: (1) surgical patients fed intravenously, (2) normal infants, (3) normal adults on a maintenance nitrogen level, and (4) normal adults who were protein depleted and fed just enough nitrogen to supply the approximate endogenous needs. Methionine supplementation did not increase the efficiency of nitrogen utilization from the casein hydrolysate.

These findings naturally led us to determine the comparative effectiveness of intact casein and of lactalbumin in promoting nitrogen retention *in man*. Four normal adults were placed on a protein-low diet (*4*) for 12 days, until a constant nitrogen excretion (assumed to be approximately endogenous) had been reached. The nitrogen intake during all depletion periods was 0.008 gram/kg. body weight/day, and for the last 4 of the initial 12 days the average nitrogen loss was 3.22 grams daily. The caloric intake during the entire 40-day study was maintained constantly at 40 calories/kg. body weight.

Four-day periods of supplementation with either casein or lactalbumin were then alternated with 4-day depletion periods. The two proteins were fed alternately, and each was administered for two 4-day experimental periods in order to minimize the effect of antecedent conditions on nitrogen balance. A level of supplementation insufficient to produce positive nitrogen balance was intentionally chosen. This level was 0.033 gram of nitrogen/kg. body weight as the test protein, equal to 2 per cent of the total calories. The average nitrogen balances for each subject for each period are given in Table 1. Subject C contracted a mild type of prevalent "influenza" and could not complete the test.

TABLE 1

Nitrogen Balances for Each Period

(Data expressed in grams nitrogen/day)

Periods (4 days each)	Subject				
	A	B	C	D	Avg.
Depletion	−3.92	−2.26	−3.81	−2.90	−3.22
Casein	−.76	−.64	−.83	−.93	−.79
Depletion	−4.13	−2.88	−3.52	−3.00	−3.38
Lactalbumin	−.65	−.47	−.69	−1.40	−.80
Depletion	−3.48	−2.29	−2.81	−2.75	−2.83
Casein	−.74	−.32	−.87	−.79	−.68
Depletion	−4.09	−2.10	—	−2.34	−2.84
Lactalbumin	−1.44	−.05	—	−.66	−.72

These experiments reveal no significant difference between the two proteins in maintaining nitrogen balance in man. The average endogenous value for the four depletion periods was −3.07 grams. The addition of casein spared 2.33 grams of body nitrogen, and the addition of lactalbumin, 2.31 grams. These average values are closer than might again be encountered, but the individual balances were within the range of variation that we have observed in this type of study. All pertinent details of the study will be published elsewhere.

We have approached the calculation of "biological value" with temerity, since, in our experience, such comparative values more often mask than disclose information. Using an average for the four depletion periods as the endogenous level of urinary and of fecal nitrogen excretion, average "biological values" are: for casein, 89.0 and 94.7, respectively; for lactalbumin, 90.2 and 93.3. In spite of the similarity in these final average figures, it should be noted that the variation in the individual values is as great as that observed in experimental animals (*3*).

We have attributed the failure of methionine to improve the nitrogen retention of a casein hydrolysate in man to the fact that man is not covered with hair. Hair contains a high percentage of cystine, and it is logical that the requirement of the rat and the dog for sulfur-containing amino acids should be greater than that of man (*1*). Whether or not this explanation is valid, these data demonstrate that lactalbumin is not superior to casein in promoting nitrogen retention in man.

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IN THE LABORATORY

Simple Syringe Burette[1]

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The use of a syringe for rapid and highly accurate delivery of fluids was introduced by Krogh and Keys (*1*), and their syringe pipette has since come into wide use. The less accurate syringe burette, described herein, and the titration procedure were developed primarily for field use. The equipment is compact and easy to operate, and gives an accuracy within 0.5 per cent for conventional titrations. The burette can also be used as a constant delivery pipette with a routine accuracy for total delivery of 0.1 per cent. The plunger can be removed at any time for cleaning without disturbing the setting of the instrument.

The burette (Fig. 1) consists of a standard 1-cc. tuberculin syringe on which is fused a 5-cm.-long, tapered delivery tip. The barrel of the syringe is provided with a split plastic block which can be clamped onto it by means of two screws (A). A straight-angle bow of stainless spring steel wire, 0.5–0.7 mm. in diameter, is press fitted into the block. The bow is so adjusted as to press slightly onto the plunger of the syringe to give it the necessary friction for a smooth operation. The plunger is notched (C) to engage the spring wire clip in order to furnish the automatic zero point. This notch is cut perpendicular to the axis of the plunger by means of a sharp-edged, triangular, medium or fine India oil stone. The cut must be sharp and straight and fit the spring steel bow without play. The notch should be located in line with the number on the plunger in order to orient the plunger regularly.

When used as a burette, it is necessary to grind the end of the plunger flat and perpendicular to the axis in order to obtain a parallax-free reading of the instrument. The grinding is performed in a block of bakelite provided with a series of holes of slightly different size. The plunger is placed in the best-fitting hole, and the block, together with the plunger, is ground against a piece of emery paper resting on a flat surface.

A split cork on the syringe barrel serves to unite the burette with the titration vessel (B).

To adjust the automatic zero setting of the burette, the syringe burette is filled with water and the block (A) loosened; while the spring engages the notch (C), the block is set so that the end of the plunger reads exactly 100. A lens should be used for reading. The graduation is calibrated by weighing the water delivered by, for example, 95 divisions, evaporation losses being most simply avoided by delivery into a tall and narrow, open weighing vial which is handled by forceps to avoid temperature gradients (*2*).

For constant delivery the plunger is moved down from the notch until it bottoms with the notch (and number) facing the bow. The end of the plunger must be ground flat, as described above, but it is left with a blunt edge so that it does not stick when moved to the bottom. The delivery is determined by weighing as described. Seven different syringe burettes were tested in this way. Out of 35 consecutive weighings, 32 agreed within $\pm$ 0.1 per cent or better.

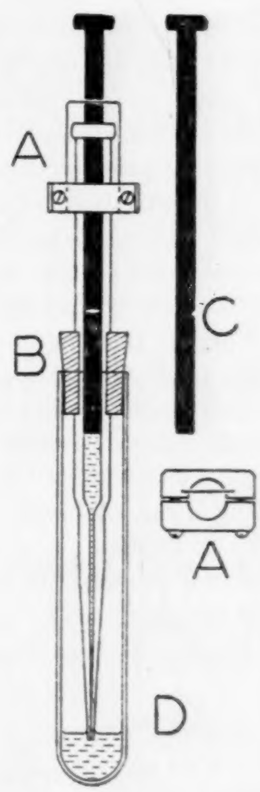

FIG. 1. Syringe burette attached to titration vial: A, plastic block with spring clip; B, split cork for uniting burette with titration vial (D); C, notch in plunger which engages spring wire (A) when the end of the plunger is at zero point of the syringe scale.

The sample to be titrated is delivered in the desired volume from a syringe or other accurate pipette directly to the bottom of the titration vial, without leaving drops sticking to the wall.

With the burette full of titration fluid (*i.e.* with the spring engaged in the notch), it is then inserted in the titration vial and fastened by means of the split cork. The tip of the burette is moved close to the surface of the sample, or slightly below, if the specific gravity of the burette fluid is lower than that of the sample.

While the whole unit is being agitated, the plunger is held by the button and moved slowly downwards by a screwing motion until titration is complete.

[1] This method was developed in connection with work on Cost Reimbursement Scientific Research and Development Contract No. W33-038-ac-14985, between the Air Materiel Command, Wright Field, and Swarthmore College (Department of Zoology).

[2] The writer is indebted to Dr. Laurence Irving for help and advice during this work. The tuberculin syringes were adapted for the present use by J. D. Graham, Department of Physiology, University of Pennsylvania.

For reading, the syringe is detached from the vial and the scale read by sighting across the flat end of the plunger and estimating to the nearest fifth or quarter of a division, again using a lens.

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Improved Technique for Enumeration of *Escherichia coli* on Black Walnut Meats[1]

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The enumeration of microorganisms found on solid materials is, in the main, based on their removal by washing a known weight of the solids with a known volume of washing fluid and then making serial dilutions from this fluid prior to the use of one of the common modes for determining numbers.

In the course of an investigation on the effectiveness of pasteurization for killing *Escherichia coli* on inoculated black walnut meats, it was found that washing the meats to remove the bacteria was not satisfactory when the Halvorson-Ziegler (*1*) method of determining the "most probable number" (MPN) of bacteria was used. The number of positive tubes found in the 10 replicate tubes of each of the three lowest dilutions gave codes which, when applied to the probability table, were equivalent to such "MPN" values as to make it evident that the seeding of the solid itself was needed if more accurate codes were to be secured.

Accordingly, an attempt was made to use the meats themselves in the replicate plantings, so that one member of the resultant code would be of no dilution. This was accomplished

TABLE 1

Test	MPN/gram	
	Washed meats	Blendor-treated meats
1	0	0.7
2	0.9	275.0
3	0	240.0
4	0	1.6
5	0	7.9
6	0	16.9
7	3.2	130.0

by cutting a known weight of the meats into small particles in a sterile Waring blendor container. After a homogeneous mass was secured and 10 replicate 1-gram samples had been removed for planting into lactose broth fermentation tubes, a known volume of sterile water was added to the container and the mixture further agitated until a creamy mass was secured. This material could be pipetted easily in making the 10 replicate plantings from this dilution, and it could also serve as the starting point for making subsequent dilutions.

The results of typical tests made on inoculated meats which had received various heat treatments are shown in Table 1. This table contrasts the "MPN" of *E. coli* per gram of meats when washing was used for the removal of these organisms with the "MPN" gained by the use of the Waring blendor procedure. Meats from the same batch were used when comparing the procedures.

TABLE 2

Test	MPN/gram	
	Washed meats	Blendor-treated meats
1	6,220	11,600
2	24,400	39,900
3	2,900	4,930
4	3,990	9,200
5	11,400	32,900
6	1,960	4,840
7	7,420	34,900

The superiority of the Waring blendor procedure is shown also in Table 2. Inoculated nut meats which had not been heat treated served as source material for contrasting the two modes of removal. Meats from the same batch were used when comparing the procedures.

The results of these tests suggest that, where the solid lends itself to subdivision, the use of the Waring blendor for this process permits the seeding of homogeneous, undiluted solid material into the tubes of broth. This procedure, together with the actual "carrying over" of the solid into subsequent dilutions, makes for a greater recovery of the organisms than that secured by washing the solid materials.

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[1] Published with the approval of the director, West Virginia Agricultural Experiment Station, as Scientific Paper No. 369.

Cultivation of Microorganisms With the Aid of Cellophane Membranes

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This brief report describes the use of thin sheets of cellophane for the cultivation of bacteria and fungi. We first used cellophane for this purpose during the German occupation, when Petri dishes were unobtainable.

A sheet of cellophane was rolled around a rod and sterilized by autoclaving. It was then unrolled on a table, and melted agar medium was poured out over the sheet. The surface was inoculated by spraying, and the agar immediately covered by a second cellophane sheet. To save space, the whole culture was finally rolled up again loosely around the rod and incubated.

Recently we have taken up the problem from another side, using the cellophane sheets not only as a substitute for glass but as a dialysing membrane. These sheets are impermeable to bacteria and viruses, but they allow the passage of water and solutes (except those of very large molecular weight). Thus, colonies of bacteria can be grown on one side of the cellophane,

nourished by fluid, which dialyses through from the opposite side of the membrane.

In our first experiments we used cellophane tubes (available as sausage skins), as shown in Fig. 1.

For the production of thick, slimy cultures on the inner side of the cellophane tube (Fig. 1a), the tube (1) is pulled over the ends of two glass tubes (2) of the same diameter and fastened to them at each end by collodion. Through the tube is passed a very slow current of air under a slight pressure, sufficient to keep the tube rigid. Through the narrow space between the cellophane tube and an outer, enveloping glass tube (3) is circulated a slow stream of the nutrient solution. All the tubes are fitted tightly in rubber stoppers (4) as shown. The culture is now growing on the inner surface of the cellophane tube, nourished through the cellophane but not

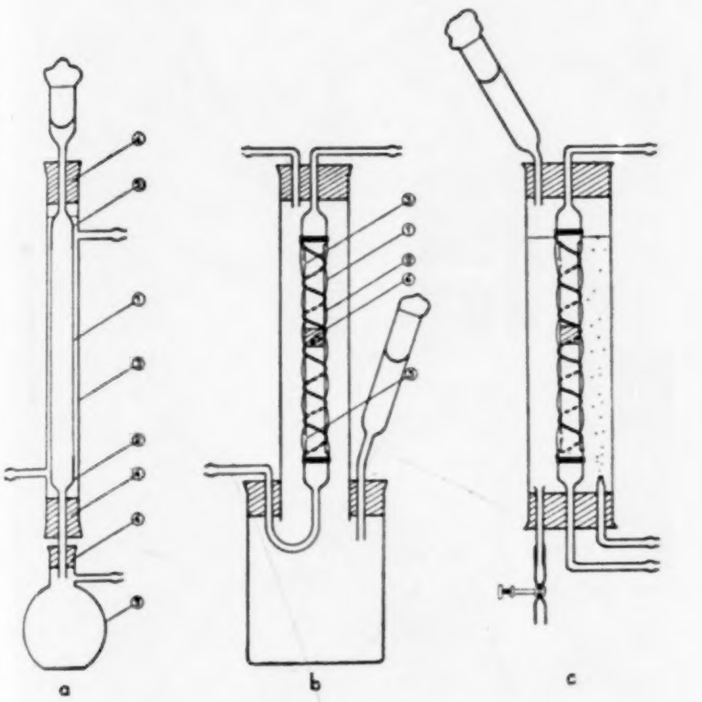

FIG. 1. The three main arrangements for experiments with cellophane tubes.

contaminating the broth. As soon as the growth becomes luxurious, the culture drips down along the tube and is collected in a container (5).

With the apparatus shown in Fig. 1b the same end is attained in a slightly altered manner. Here the culture grows upon the outer surface of the cellophane tube (1), while the nutrient broth circulates between the cellophane and a narrower glass tube (2) inserted in the cellophane tube. To prevent the cellophane from sticking to the surface of the inner glass tube, a string is wound spirally around the cellophane tube. The current is thus forced to circulate spirally around the inner tube. The nutrient solution is fed and drained off through the inner tube, which has two small openings (3) near the top and the bottom but is closed by a rubber stopper (4) between these openings.

In the third type of apparatus, shown in Fig. 1c, the culture grows not upon a cellophane surface in an air-filled space but in a nutrient broth with aeration only by a stream of filtered air, this gives a fluid, but finally very thick, culture.

This method of cultivation is of use when large amounts of bacteria (free from substrate protein) are required (e.g. rhizobia for the inoculation of leguminous plants). It has the added advantage that the culture can be grown without interruption and, if the nutrient broth is renewed from time to time, for an unlimited period. Furthermore, this principle may also prove to be of use for the study of bacterial products, which can thus be obtained free from substrate protein in the dialysate.

Our first experiments proved that the method was sufficiently productive. The apparatus shown in Fig. 1 (a or b) gave within 10 days, at 29° C., 15 grams of a rather stiff, slimy culture of *Rhizobium* of a quality similar to that derived from agar-plate culture, the total surface of the cellophane tube being 100 cm.², while the surface of agar plates for production of the same amount in similar circumstances would be nearly 150 cm.².

We do not know whether others have used cellophane in culturing bacteria or studying their metabolism; recently we have found a short communication (*1*) on the interaction of different bacteria suspended in nutrient solutions and separated from each other by collodion membranes.

The above-described method, of course, does not require that cellophane membranes be used solely. Other types of membranes may be even more suitable for some purposes.

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Laboratory Test of Aviator's Ejection Seat

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Emergency escape from high-speed aircraft is dangerous and sometimes impossible. It is not only difficult for the pilot to leave the cockpit against the force of the wind stream, but he may fail to clear plane structures as he is swept backwards along the axis of flight. In spins he may be unable to move, and at low altitudes there is often insufficient time to abandon the plane in an emergency. The most serious hazard is collision with the tail surfaces after leaving the cockpit.

Development of an ejection seat which instantaneously catapults the pilot from the plane was started in Germany during the last war (*2*) and has been continued and improved by the British (*1*). The U. S. Army and Navy are adapting and developing such devices for service aircraft from which escape is at present dangerous. Each of these groups of workers has successfully ejected aviators from planes in flight under experimental conditions.

Catapulting the seat from the plane provides an escape possibility limited by the dimensions and motion of the plane at the time of ejection and by the tolerance of the aviator to ejection. The primary restriction is the vertical distance in the cockpit available for imparting velocity and direction to the catapulted seat and pilot.

[1] The opinions expressed in this article are those of the authors and are not to be considered as reflecting those of the Navy Department. Appreciation is expressed to A. T. Kornfield and D. Weiss for the design of the velocity meter and pressure pickup and the operation of the instrumentation for these experiments.

The maximum speed of any particular plane at which the aviator may be safely ejected is determined by human tolerance to rapid acceleration. The physiology of this phenomenon is not well understood. Compression fractures of vertebrae or extrusion of intervertebral disc are believed likely to occur at accelerations, applied from seat to head, of approximately 23–25 times the acceleration due to gravity ("G"). The relations between exposure time and the critical level of acceleration which is likely to cause vertebral damage are not known. A subcritical level of acceleration applied to the seat in an elastic system may result in accelerations above the critical level in integral parts of the system. If this should occur in the spine over significant intervals of time, injury may result.

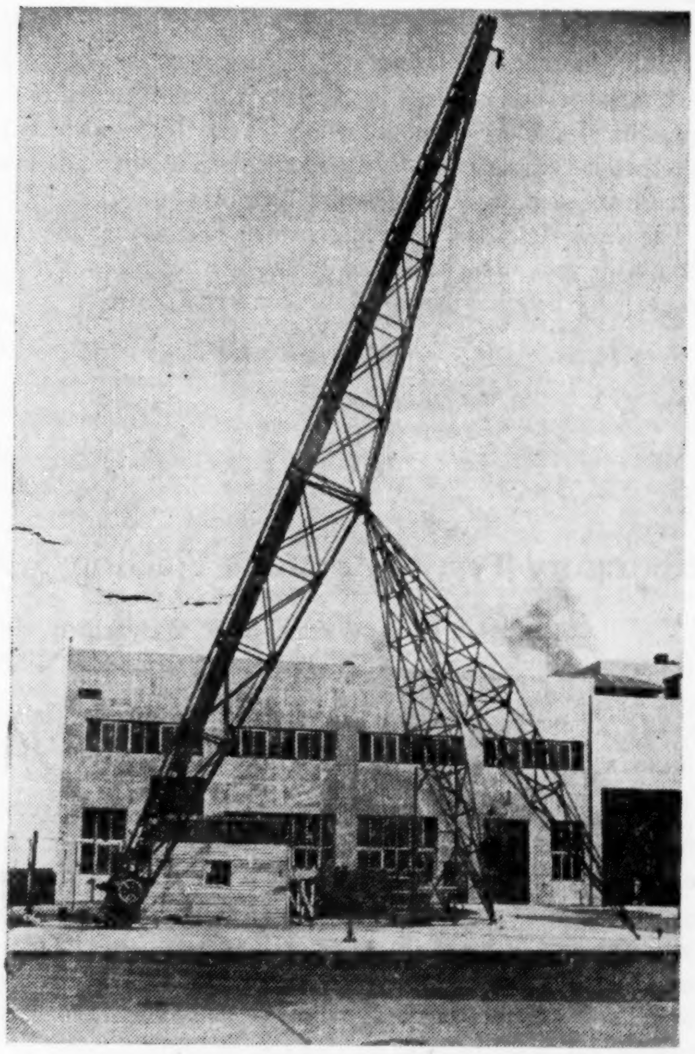

FIG. 1. Side view of 105-foot ejection seat test tower.

Previous investigations, limited by the lack of satisfactory instrumentation and test facilities, have failed to follow events in human subjects exposed to accelerations by high-performance ejection devices. The present study has helped to establish safe methods for the ejection of personnel from high-speed aircraft with a propelling device of limited stroke.

Method. A 105-foot ejection seat test tower and experimental catapult were procured from Martin-Baker Aircraft, Ltd. (Fig. 1). The catapults are cartridge-exploded piston and cylinder tubes 40, 52, and 60 inches long. A subject or dummy, strapped in a conventional aircraft seat with a standard retention harness (Fig. 2), is ejected up guide rails 70° from the horizontal by means of the powder-operated catapult. The charge is fired when the subject pulls a canvas curtain from above the head down in front of the face to the level of the chest. During the following acceleration this curtain partially supports the weight of the arms and shoulders and prevents extreme forward flexion of the cervical vertebrae. The seat is held at the top of the ascent by ratchets and is subsequently lowered by a cable operated from the ground.

Acceleration is measured on the seat and on the subject's hip, shoulder, and head by Statham (Model R-40-450) accelerometers mounted at these points (Fig. 2). Catapult pressure is recorded with a strain-gauge pressure pickup. Seat velocity is obtained by means of a coil attached to the seat and passing over magnets spaced at 2-inch intervals parallel to the motion of the seat. Maximum velocity can also be obtained by calculation from the ejection height. All data signals are simultaneously recorded with a Consolidated oscillograph (Model 5-101A).

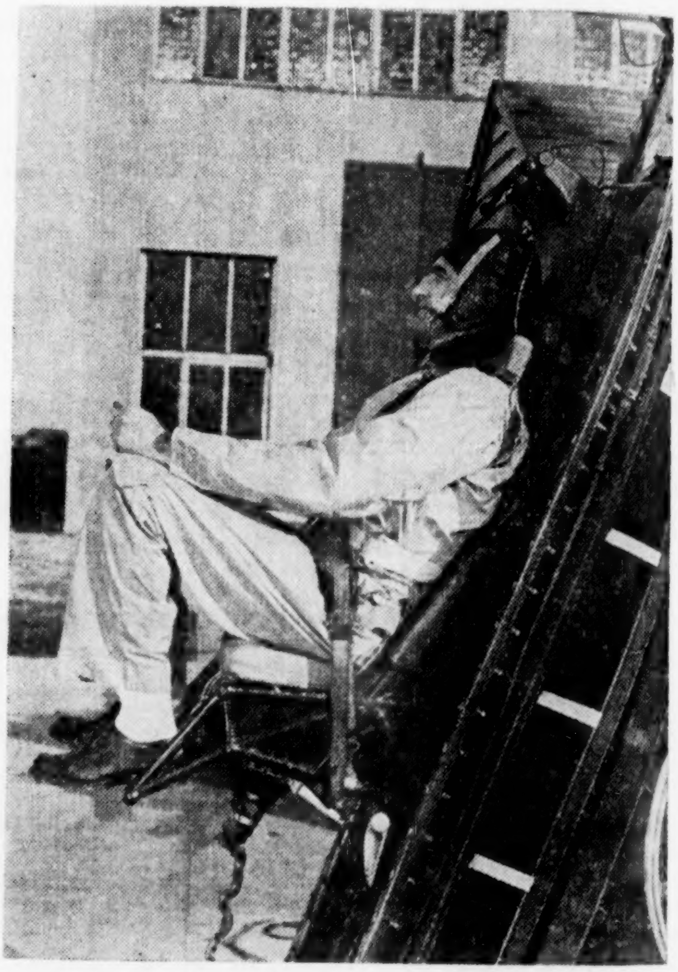

FIG. 2. Subject on test seat with accelerometers secured to hip, shoulder, and head. Handles of firing curtain can be seen above the head.

Since it was expected that vertebral injury could occur with little or no warning, subjects were progressively exposed to increasing accelerations. Three dummy ejections were made for each experimental arrangement. If maximum acceleration did not exceed 21–22 "G", volunteer subjects were then used under the same conditions. The subjects had average physiques and could be considered as a cross section of workers at a research station. Their ages ranged from 19 to 53 years, and weights from 130 to 195 pounds. In addition to preliminary experiments, 48 ejections have been made with 21 subjects, using a standardized charge designed to produce a maximum acceleration of 18–20 "G".

Results. An oscillograph record of an experiment on the test tower is shown in Fig. 3. Average data from representative ejections with each type of catapult are given in Table 1. If any subjective reaction resulted from these high accelerations, it was usually a mild pain in the lumbar, thoracic, or cervical regions followed by a generalized soreness. No injuries have occurred, and individuals could probably tolerate the rate of onset of acceleration increased. This excessive acceleration, technically the dynamic factor, is to be expected in a springmass system such as the seat-cushion-man. Compromises may have to be effected between rate of acceleration, maximum level and duration of acceleration, and cushioning devices for seat ejection at the highest velocities which can be safely tolerated in any particular airplane.

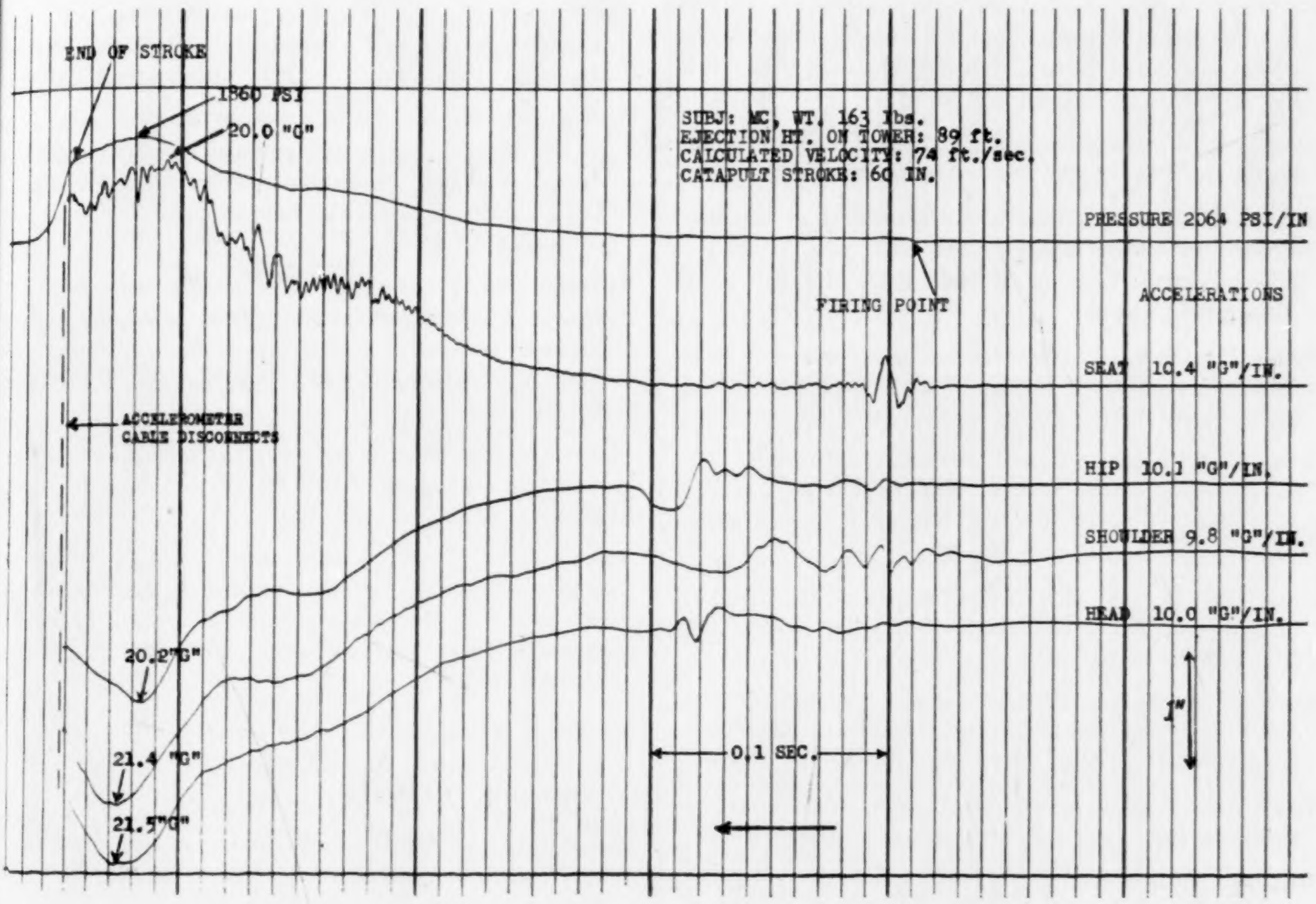

FIG. 3. Oscillograph record showing accelerations recorded on a subject during ejection on test tower.

slightly higher accelerations, but 20–22 "G" is believed to represent the practical upper limits for seat ejection experiments. Satisfactory escape devices can probably be developed without exceeding these limits.

TABLE 1

No. subjects	Avg. wt. (lbs.)	Catapult stroke (in.)	Avg. seat "G"	Avg. hip "G"	Avg. shoulder "G"	Avg. head "G"	Avg. maximum velocity (ft./sec.)
5	172	40	17.2	17.6	18.4	17.8	55.8
5	164	52	17.8	19.3	17.4	16.6	63.9
4	165	60	19.9	20.5	21.3	19.8	71.2

Additional research is necessary to determine the optimal system for ejection from aircraft. In some of our experiments with catapults producing a range of rates of accelerations, the "overshooting" of "G" recorded on the subject, compared to that recorded on the seat, became progressively greater as

It is also believed that myotatic reflexes are important in protecting individuals exposed to high acceleration. Adequate time should be allowed for reflex muscular contraction before reaching a critical level of acceleration. Details of experiments to determine factors affecting man's tolerance to impact-like accelerations will be given in a later publication.

These experiments have shown that under controlled laboratory conditions personnel can be safely exposed to high, impact-like accelerations with a minimum of discomfort. Data obtained can be used for the design and predicted performance of ejection seats for use in aircraft. Using a catapult similar to those tested in the laboratory, an aviator was successfully ejected from a plane at an airspeed of 250 m.p.h. On the basis of laboratory data it is expected that ejections can be made at much higher speeds.

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